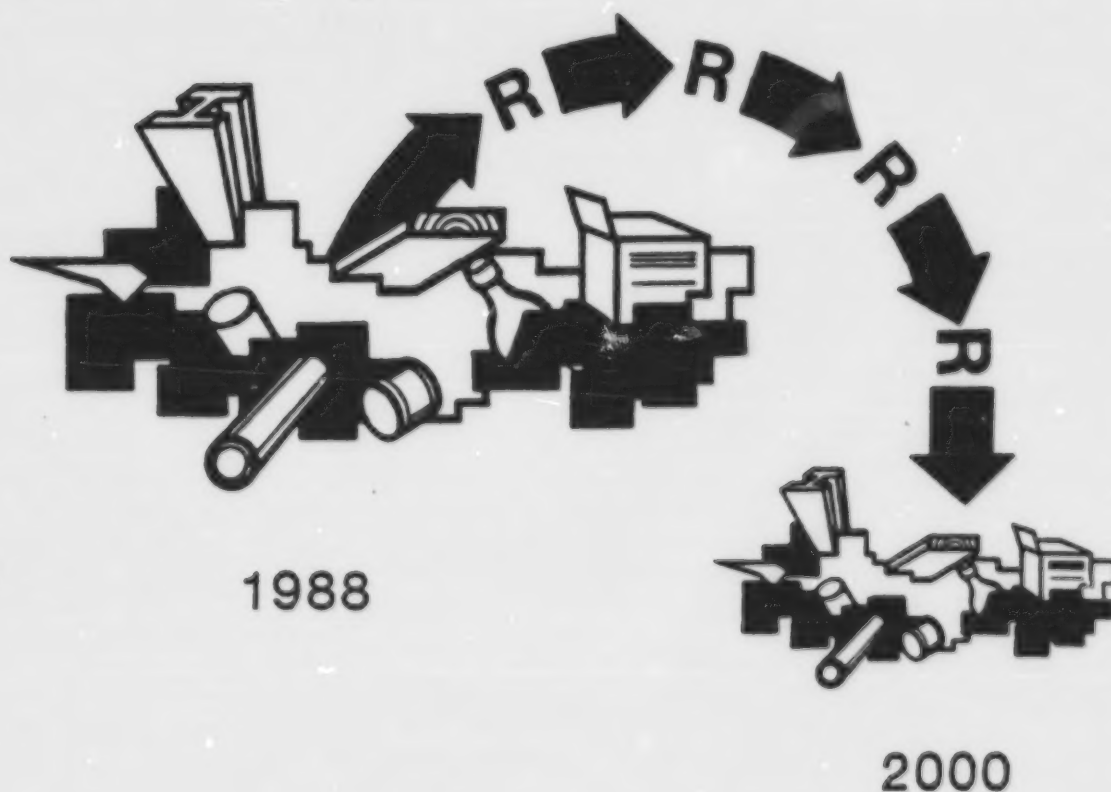


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de l'environnement

Packaging Reduction, Reuse and Recycling Technology Options



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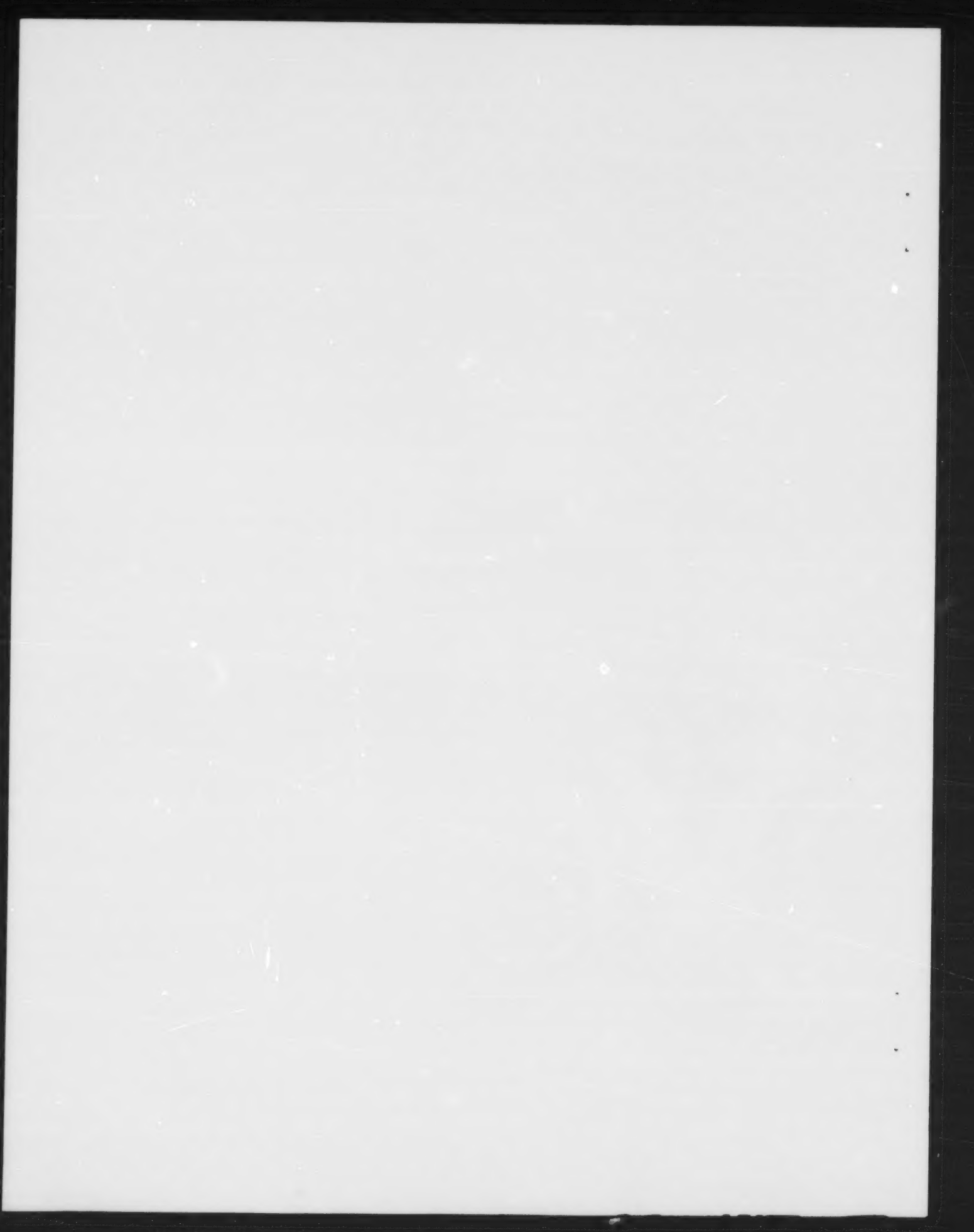
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READERS COMMENTS

Readers who wish to comment on the content of this report should address their comments to:

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PREFACE

This report is one of a series prepared for the National Packaging Task Force in support of the development a national packaging policy for Canada. The complete series of reports is as follows, together with the companies that prepared them:

- | | |
|---|---|
| • Packaging Application in Canada; | MacLaren Engineers Inc. |
| • Packaging Reduction, Reuse and Recycling Technology Options; | MacLaren Engineers Inc. |
| • Stakeholder Positions and Response to the Development of the National Packaging Protocol; | MWR and Associates |
| • Household Consumers and Packaging; | Resource Systems Management International |
| • Legislative Initiatives Relating to Packaging and Implications for the National Packaging Protocol; | Resource Systems Management International |
| • Economic Considerations in the Development of the National Packaging Protocol; | The Coopers and Lybrand Consulting Group |
| • Environmental Life Cycle of Packaging; | VHB Research and Consulting |
| • Agenda for Action for the National Packaging Protocol; | Recycling Development Corporation |

The key data and analyses of each of these reports are included in a further report titled The Technical Basis For The National Packaging Protocol: Summary Report prepared by MacLaren Engineers Inc. Input to all reports has been received by M. J. Ramsay and Associates.

The National Packaging Task Force is a multi-stakeholder task force comprised of representatives from federal, provincial and territorial governments, municipalities, industry, environmental groups and consumer groups. The goal of the task force has been to develop and recommend to the Canadian Council of Ministers of the Environment a national packaging

policy for Canada.

In March 1990, the Canadian Council of Ministers of the Environment adopted the national packaging policy that was recommended to it by the National Packaging Task Force. The policy takes the form of a National Packaging Protocol that has been agreed to by all members of the task force. The National Packaging Protocol is included in this series of documents as Appendix A of The Technical Basis For The National Packaging Protocol: Summary Report.

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EXECUTIVE SUMMARY

E.S. 1.0 Executive Summary

E.S. 1.1 Summary of Data

The central objective of this report is to identify the packaging 3R opportunities that are technologically possible today. This sets maximum limits on the impact that 3R approaches can have on the management of current packaging in the absence of economic, social, legislative or other possible barriers. This approach is not intended to ignore the importance of these other factors on the level of 3R activity that is actually possible. Rather, it provides a context in which to analyze the significance of these other factors, all of which are considered in detail in other reports prepared in support of the development of the National Packaging Protocol.

The preparation of this document has been undertaken with extensive consultation with packaging suppliers and packaging users. In particular, all quantitative estimates of 3R potential have been discussed with industry. In many cases, however, it is not possible to precisely identify the impact of a particular 3R initiative. In these cases, probable 3R impacts have been discussed with industry and estimates of impacts have been quantified based on consensus with the industries concerned.

Table ES-1 identifies the estimated potential technological impact of 3R opportunities on the management of packaging materials. As this table indicates, technological reduction potential is estimated at 9 percent by weight. Technologically, an estimated one-third of packaging by weight could be designed as reusable packaging in current applications; in 1988, an estimated 11 percent of packaging was reusable. Approximately three-quarters of packaging by weight could be recycled from a technological perspective; in 1988, an estimated 18 percent of discarded packaging was recycled.

There is high consensus within industry that the reduction potential identified for each packaging material in Table ES-1 is technologically achievable. In the case of

Table ES-1

**Estimated
Potential Technological Impact
of 3R Opportunities
on
Management Of Packaging Materials - 1988¹**

Material	Reduction		Reuse		Recycling	
	Percent	Tonnes	Percent	Tonnes	Percent	Tonnes
Paper	14	(392,000)	20	(563,000)	80	(2,252,800)
Steel	5	(19,000)	8	(30,400)	100	(380,000)
Aluminum	5	(1,500)	0	(0)	80	(60,400)
Plastics	5	(41,000)	12	(98,760) ²	50	(411,500)
Glass	10	(73,500)	30	(220,000) ³	75	(551,250)
Wood	<1	(Minimal)	90	(714,000)	98	(778,120)
Overall Technological Potential	9	(527,000)	33	(1,847,160)	78	(4,434,070)
Existing Packaging Management			11	(577,000)	18	(961,000)

¹ 3R potential for composites has traditionally been low. Composites may be lighter than other materials, so their environmental benefits to date have been primarily in areas such as reduction of energy required for transportation and reduction in materials required for manufacture. New efforts are not underway to develop 3R management systems for composites, notably by Tetra-Pak with respect to aseptic packaging.

² Reuse could be increased if the design of packaging were altered (e.g. flexible to rigid packages) in many applications. Reuse of plastics is currently restricted in food and beverage applications by health regulations.

³ This figure approximates current reuse of beverage containers.

(ii)

paper/paperboard packaging, achievement of the estimated reduction potential would require amendment of standards that are required for insurance purposes, but which the industry considers out-dated. In all cases, estimated reduction potential is based on the lightweighting and thinwalling of packaging and containers.

Reuse potential is more difficult to quantify. The data in Table ES-1 estimate reuse potential on the basis of the technological feasibility of reusing existing packaging materials in their current applications. In some cases, achievement of the estimated technological reuse potential identified in Table ES-1 would require product redesign; in the case of wood packaging, for example, all pallets could be reusable if manufactured from dense-grained tree species. The glass industry maintains that higher levels of reuse than indicated in Table ES-1 for that material are not possible, although others have suggested that the technological potential for glass reuse is at least double the estimate in Table ES-1 if it is assumed that all glass used by the food and beverage industry were redesigned for reusability and appropriate reuse infrastructures were put in place.

There is high consensus on the estimated technological potential for recycling. Industry already has well-defined technical standards relating to the amount and specifications of secondary material that can be used in the manufacture of new products. The estimated current recycling potential associated with plastics is low relative to other materials due to the strict technical requirements for recycling single-resin plastics and the emergent stage in Canada of mixed-resin plastics recycling technology; as new plastics recycling technologies now being demonstrated in Canada become proven, potential for plastics recycling will rise.

It should be noted that the data in Table ES-1 are not additive. The tonnage data provided in the table identify the estimated tonnage impact that would have occurred in 1988 if the 3R opportunities identified had been fully realized. If the estimated reduction opportunities had been fully realized, however, a reduced weight of packaging would have been available to be impacted by reuse and recycling opportunities. In addition, the realization of reuse opportunities may severely constrain reduction opportunities associated with lightweighting and thinwalling, since stronger packaging may be required to withstand the rigours of reuse

systems.

The quantitative impact of non-technological 3R opportunities (e.g. bulking/dispensing systems, standardization, increasing product concentration, converting from disposables to durables and other forms of substitution) are difficult to quantify. However, depending on the extent to which they are implemented, they may increase reduction, reuse and recycling very significantly above the technological potential outlined in Table ES-1. Clearly, the realization of non-technological opportunities for the 3R management of packaging can have an important role to play in enhanced 3R management of packaging overall. However, the realization of non-technological opportunities for the 3R management of packaging requires that choices be made about packaging systems themselves and, in some cases, the products they contain. While it is important to recognize the important potential contribution of non-technological opportunities to the 3R management of packaging, the quantification of these opportunities is beyond the scope of this document.

E.S. 1.2 Conclusions and Recommendations

There is widespread agreement in industry that the technological potential for the diversion of packaging from disposal through 3R approaches is great. Thus, while new and better technology is always desirable, we have the technological potential today to divert the major proportion of packaging from disposal. Technology is not currently the limiting factor in enhanced 3R management of packaging; the key issues related to the enhanced 3R management of packaging relate to the economic, legislative, social and other factors that must be considered in creating an environment conducive to maximizing the application of 3R technology. New initiatives to divert packaging from disposal should not necessarily wait for new technology but must be sensitive to other factors that affect how, when and to what extent 3R technologies are applied.

Significant 3R activity is currently being undertaken to divert packaging from disposal. This activity is occurring with respect to both consumer and industrial/commercial packaging. Consequently, infrastructures exist on which to build greater efforts to divert packaging from

(iv)

disposal. Infrastructures vary across the county; however nowhere are they sufficient to accommodate the level of 3R activity that will achieve the technological 3R potential for the management of packaging identified in this document. The development of expanded infrastructures should be a priority activity to enhance the 3R management of packaging.

Maximizing the impact of 3R approaches on the diversion of packaging from disposal will require an integrated approach that recognizes technological and non-technological 3R management options. In the development or choice of environmentally preferred packaging, trade-offs are likely to be necessary between each 'R'; for example, the choice to maximize source reduction may preclude reuse of a package, or may involve adoption of a non-recyclable package. The basis for choosing environmentally preferred packaging and packaging management systems should include consideration of not simply whether appropriate technology exists to implement a particular 3R strategy, but where the technology exists (i.e. can it serve a national or only regional market) and the extent that economic, legislative, social or other factors may limit application of the technology.



1.0 INTRODUCTION

1.1 Purpose

The National Packaging Protocol, in both its general strategies and specific goals, must rely upon reduction, reuse and recycling (3R) options in order to achieve its goals for the diversion of packaging from disposal. Consequently, the Protocol must reflect the potential for reduction, reuse and recycling of packaging materials through technological and non-technological means.

The central objective of this report is to identify the packaging 3R opportunities that are technologically possible today. This sets maximum limits on the impact that 3R approaches can have on the management of current packaging in the absence of economic, social, legislative or other possible barriers. This approach is not intended to ignore the importance of these other factors on the level of 3R activity that is actually possible. Rather, it provides a context in which to analyze the significance of these other factors, all of which are considered in detail in other reports prepared in support of the development of the National Packaging Protocol.

The preparation of this document has been undertaken with extensive consultation with packaging suppliers and packaging users. In particular, all quantitative estimates of 3R potential have been discussed with industry. In many cases, however, it is not possible to precisely identify the impact of a particular 3R initiative. In these cases, probable 3R impacts have been discussed with industry and estimates of impacts have been quantified based on consensus with the industries concerned.

This section provides an overview of the definitions and general approach adopted by this report. The following several sections consider specific 3R opportunities in the various packaging industries. Non-technological 3R opportunities are identified. Conclusions on the overall technological potential of 3R approaches on the management of packaging are then provided together with recommendations for actions to be taken.

1.2

Overview of Packaging Materials and 3R Definitions

Packaging is used to contain, transport, protect and market goods, and to provide product information. It is commonly composed of paper or paper products, plastics, aluminum, steel, glass or wood. Composite packaging is also used; this packaging is composed of two or more types of material or two or more layers of the same material, for example plastic. Typical forms of packaging include pallets, boxes, bottles, cans, jugs, drums, wrappers etc. Packaging plays a central role in the Canadian economy and contributes significantly to the high standard of living enjoyed by Canadians.

Packaging may be designed for one trip, several or infinite trips, depending on many factors such as the product, packaging type, destination, economics, health and safety concerns local suppliers and company preference. Reusable packaging may require washing and/or relabelling, or it may simply be used again. In some cases, packaging reuse may involve the return of the package to a manufacturer or distributor. Domestic reuse of some packaging is also common; for example the reuse of grocery bags as garbage bags. Data is not available on the extent of the domestic reuse of packaging, however, and while it is acknowledged to be significant in some cases it is considered beyond the scope of this document.

Among non-reusable packaging, some is recyclable, some is potentially recyclable (technically and economically), while some is non-recyclable (technically and/or economically). In some recycling processes, used packaging can be remade into its original form and used for its original purpose. This is referred to as 'closed loop' recycling, representing a primary use for the material.

Secondary recycling refers to the use of the packaging material for a use other than its original one due to a loss of, or change in, material quality or contamination or lack of market opportunity for the use of the material in manufacturing the original products. The resource value, and often the economic value, of the packaging material is generally maximized in closed loop recycling, so it is preferred over secondary recycling. Secondary recycling may

have a negative impact on the overall marketing network for all recycling materials due to the downward spiralling of potential uses.

Reduction in packaging quantities can be accomplished in six main ways:

- 1) the manufacturing of packaging using less material e.g. through lightweighting and thinwalling;
- 2) substitution of heavy materials with lighter ones;
- 3) enhancing reuse, thereby reducing packaging unit requirements;
- 4) increasing product concentration, resulting in smaller packages;
- 5) bulk selling; and
- 6) minimizing the number of layers of packaging used to package a product.

1.3 Packaging Materials And Industry Sectors

This document identifies opportunities for the 3R management of packaging on the basis of the major packaging material categories: paper/paperboard, metals (steel and aluminum), glass, glastics, wood and composites. This approach has been adopted in order to most rapidly identify the overall magnitude of 3R opportunities that are technologically possible.

An alternative approach would be to identify 3R opportunities on the basis of the packaging used by specific industry sectors. This approach would lead to a more specific identification of 3R opportunities; for example, it would lead to assessment of potential wood packaging reuse in the machinery sector as compared to the transportation sector. This approach also has the advantage of reflecting the fundamental economic reality of packaging supply: packaging is created and used in response to the demands of industry and consumers.

On the other hand, identification of technological 3Rs opportunities by sector is extremely time-consuming because it requires analysis of each of the 22 Standard Industrial Classification groups in Canada. This document is intended, therefore, to identify broad 3R opportunities and to estimate the potential magnitude of the opportunities. An in-depth sectoral approach may be necessary in implementing the 3R opportunities identified.

1.4 Current Management of Packaging

Table 1.1 indicates how packaging is currently managed after use in Canada. Figures are provided according to material type. Table 1.2 indicates the use of recycled materials in the production of new packages.

It is clear from examining the table that some material sectors, such as paper, aluminum and glass have already made progress in realizing their recycling potential. Wood and glass are the only material sectors which have a significant reuse component in their management. Lightweighting has been varied, with steel and aluminium having significant results and glass, plastic and paper having encouraging results as well.

1.5 Role of Technological and Non-Technological 3Rs Initiatives

3R initiatives which contribute to the diversion of packaging from landfill can be technological or non-technological in their orientation. For example, lightweighting of a container is a technical initiative. It requires changing a specific manufacturing process to reduce the material input required to produce a container of equal size that fulfils the same purpose as its predecessor. In contrast, eliminating a layer of packaging which is unnecessary for the protection of the product, thereby reducing the quantity of packaging consumed, represents non-technological reduction. The consideration of enhanced 3R management of packaging must take into account both technological and non-technological approaches although, as discussed in this document, the quantification of non-technological 3R opportunities is beyond the scope of this document.

Table 1.1

MANAGEMENT OF POST-USE PACKAGING MATERIALS

Material	% Recycled	% Reused	% Reduction (since 1970)
Paper/Paper Products			
- wrapping			
- molded pulp	39	<1	varied
- boxboard and folding cartons			
- corrugated cardboard			
Plastics	<2	<1	up to 50
Aluminum			
- cans	33	0	20
- foil	0	0	unknown
Steel			
- cans	7.5 ¹	0	30
- drums	5 - 10	5 - 10	0
Glass	21	20 - 30	22
Wood			
- pallets and crates	3	40	0
Composites	<1	<1	-

¹ Mostly in Ontario

Source:

Industry discussions and estimates.

Table 1.2

TYPICAL USE OF RECYCLED MATERIALS IN PRODUCTION OF NEW PACKAGES

Material	Proportion of Recycled Materials	Proportion of Virgin Materials
Paper/Paper Products	18	82
Plastics	<1	99.5
Aluminum	25	75
Steel	5 - 10	90 - 95
Glass	21	79
Wood	10	100
Composites	0 - 1	99 - 100

Technological initiatives tend to be specific to a material type, increasing the potential for either reduction, reuse or recycling. Non-technological initiatives are typically focused on general management principles that impact on packaging design, management and the resultant waste quantities. Examples of these general management principles include standardization, distribution/collection systems, bulk/dispenser systems, increasing product concentration, elimination of packaging that is in excess of product protection and longevity requirements, and package simplification (e.g. single material types).

In the next several sections, existing production processes, technological and non-technological options for reduction, reuse and recycling and 3Rs technology priorities are discussed according to each packaging material type. A quantitative analysis is provided in section 10 of the estimated potential impact of 3R technological opportunities. These should not be considered as targets for 3R activity since they consider only technological potential without consideration of economic, social, legislative or other factors. These factors are discussed elsewhere (see the Preface to this report).



2.0 PAPER AND PAPERBOARD

Paper and paperboard packaging continues to be the largest packaging sector in Canada. The industry has four major sub-sectors: corrugated cardboard containers, wrapping (Kraft) paper, folding cartons and set-up boxes and moulded pulp and sanitary food containers.

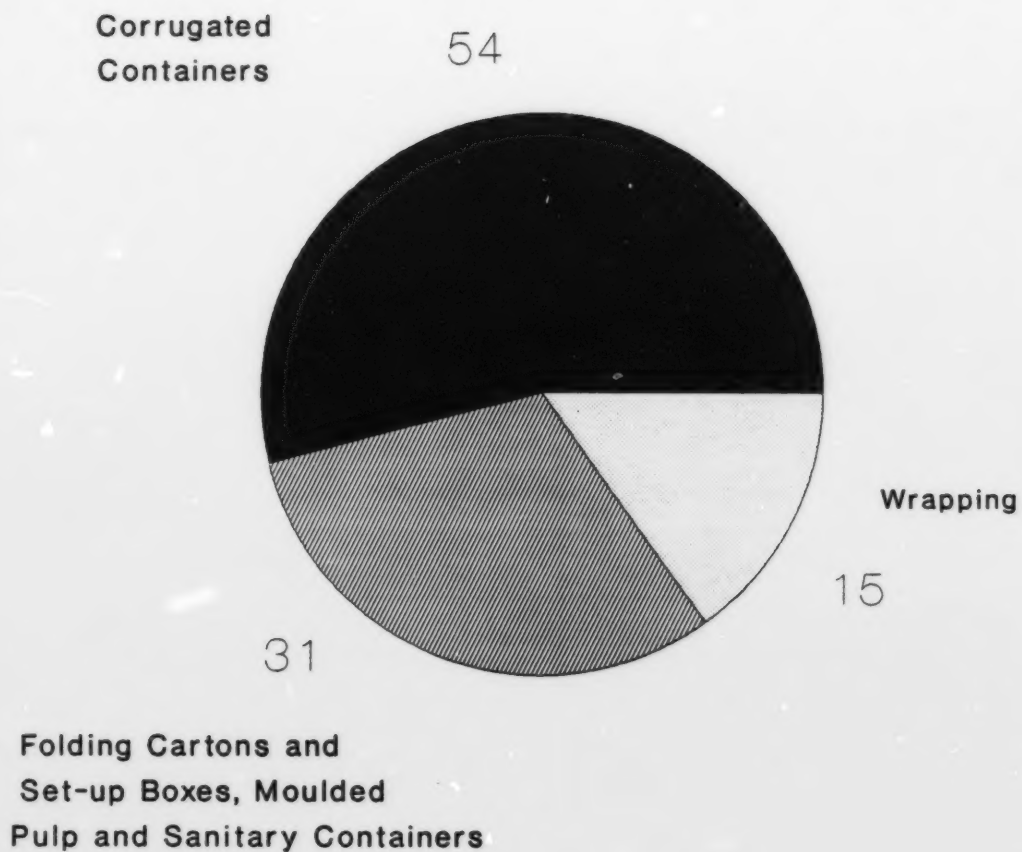
Total Canadian production of paper/paperboard packaging is estimated at 2.545 million tonnes in 1986. After accounting for growth, imports and exports, it appears that the Canadian market for paper/paperboard packaging was 2.816 million tonnes in 1988, comprised as indicated in Figure 2-1.

Detailed data on the application of paper/paperboard packaging has not been available to date. However, some general comments can be made:

- corrugated containers are used widely in residential, food and beverage, consumer and industrial goods applications;
- wrapping paper is used chiefly in heavy-duty industrial shipping sacks, and in grocery store check-out bags;
- folding cartons are made from boxboard and are used in a wide range of consumer and grocery product applications. Some cartons, such as cigarette packages, require construction using solid bleached sulphate, containing 100% bleached virgin fibres to provide additional strength needed for dispensing machines. Other cartons may be constructed using the less durable white-lined newsboard, which contains recycled fibres. Estimated at one percent of the sales of this subsector, the set-up boxes (e.g. shoe boxes) consist of the newsboard material; and

FIGURE 2-1
USE OF PAPER AND PAPERBOARD
PACKAGING IN CANADA
1988

(Values as a %)



Total amount of paper and paperboard used in packaging
estimated at 2.816 million tonnes.

- moulded pulp paperboard comprises many of the sanitary food containers include, for example egg cartons, milk cartons and ice cream containers.

Import and export in corrugated containers and folding carton/set up boxes is minor and can be assumed to have zero impact on the quantity of these materials in the waste stream. Trade in wrapping paper is significant, and 55 percent of Canadian production was exported in 1986 against imports equivalent to 10 percent of Canadian production.

Growth in paper/paperboard packaging is projected at 1.7 percent annually over the next 10 years. The four sub-sectors have widely varying rates of growth, however, corrugated cartons are projected to grow by 3 percent annually and folding carton/set up box carton/moulded pulp/sanitary containers are projected to grow by 1 percent annually. Demand for wrapping paper is projected to decline by 1 percent annually.

Table 2.1 summarizes current Canadian production, trade and growth of paper/paperboard packaging.

Data on the recycling of paper/paperboard packaging in Canada is imprecise. Overall, industry data indicates recycling of paper/paperboard packaging is in the order of 39 percent of production in Canada. These materials have high recycling potential and, in the case of corrugated cartons, reuse potential as well.

2.1 Overview of Paper/Paperboard Packaging Production

The processes for manufacturing paper wrappings, boxboard and corrugated vary, but the production processes for the manufacture of paper and paper products can be described generally to provide a basic understanding of the processes involved.

Pulp logs, mill wastes and, in some instances, paper products collected for recycling, are sorted/prepared. The pulp logs are often debarked and chipped, while the other resource

Table 2.1

Estimated Use of Paper
And Paperboard Packaging In Canada

(tonnes)

	Canadian Production Of Paper/Paperboard Packaging ⁽¹⁾	Export Of Paper/Paperboard Packaging Product ⁽²⁾	Imports of Paper/Paperboard Packaging Product ⁽³⁾	Net Use of Paper/Paperboard Canada ⁽⁴⁾
1988	3,272,000	949,000	493,000	2,816,000
1991				2,863,900
1994				2,912,600
1997				2,962,100
2000				3,012,400

Sources:

⁽¹⁾ Industry, Science and Technology Canada, Industrial Profiles on Corrugated Containers, Folding Cartons And Set Up Boxes, and Kraft Papers; discussion with Canadian Pulp and Paper Association; and discussion with the Paper Box Manufacturers Association; and Statistics Canada, Paper and Allied Products Industries (Cat. No. 36-250), 1986.

⁽²⁾ Statistics Canada, Exports by Commodity (Cat., No. 65-004)

⁽³⁾ Statistics Canada, Imports by Commodity (Cat.No. 65-007)

⁽⁴⁾ Growth based on compound weighted average annual growth of 1.7% assuming 3.0% annual growth in use of corrugated containers, 0.7% annual negative growth for Kraft wrapping papers and 1.0% annual growth for folding carton and set-up boxes growth rates estimated by Industry, Science and Technology Canada. Growth in moulded pulp is assumed to be equal to growth in the folding carton and set-up box industry.

inputs must be analyzed for composition and examined for contaminants. Pulp from wood and pulp from waste paper are produced in separate processes and then mixed. The crude pulp is then screened and washed to produce a fine, purified pulp which is then thickened and may be bleached. The pulp is then prepared according to the standards required for the specific paper application. For example, it is sized, dyed, put through the paper machine, finished and converted, using coating chemicals as required to achieve the desired results.

2.2 3R Opportunities

Reduction

There are hundreds of grades of paper, each with defined standards which must be conformed with to 'make the grade'. The standards apply to paper characteristics such as brightness, strength and resistance to tearing. Paper packaging grades are largely a reflection of strength values and applications of paper packaging grades are largely determined by user strength requirements.

However, some regulations specifying fibre orientation and weight in corrugated cardboard appear outdated. Edge crush resistance is a proposed new measure that would take into account stacking strength and impact resistance, rather than bursting strength (which the current regulations are based on). Their updating as they apply to corrugated cardboard could result in a 20 - 25% reduction in material requirements for corrugated containers.

Lightweighting of paper packaging can be achieved without also reducing its strength when the appropriate designs and grades of paper are used. For example, most boxboards have been lightweighted in the past 10 years. Although, with the predicted increase in the use of recycled fibres, which typically have shorter and weaker fibres, increasing strength to weight ratios is unlikely in some sectors. However, companies who use paper/paperboard packaging for their products can consult with their buyers and the paper industry to see if they are using a paper grade that provides more strength than is required for their specific applications. The estimated overall impact of this initiative would be a reduction within the 5 - 10% range.

The technological opportunities for reducing paper-based packaging are related to the application and to regulations. Potential also exists for reduction by assessing the critical assessment of needs, according to product protection and transportation requirements only. Boxboard, for example is a common 'outer shell' of consumer goods packaging in both food and non-food applications. The handling of the product in the store and on the shelves might be altered slightly, but the product would not be affected. For example, removing the boxboard layer from toothpaste would mean that the tubes would not stack in the same way on the shelf. Toys and hardware are two sectors where reductions in boxboard packaging use could be achieved without negatively affecting product quality or safety.

The compatibility of the 'internal' package with regular shelf appearance could easily evolve positively. Caps with a slightly larger base could be employed in applications such as toothpaste tubes, which would allow the product to stand freely on its cap. The cap would replace the boxboard packages which also allowed the product to stand freely on the shelf. Whether the increase in cap size would offset reduced boxboard usage would need to be assessed on a case-specific basis.

The overall result, may be a reduction of up to 100% in the use of boxboard for most applications where boxboard is an 'outer' layer, with its needs external to those of product protection and transportation.

To demonstrate the validity of the potential reduction which can be achieved by eliminating, in some instances, the paperboard layer of packaging, the following is a list of boxboard applications which could potentially be eliminated without negatively affecting product quality or safety:

- . contact lens solutions,
- . toothpaste,
- . some detergents,
- . some margarines,

- . single serving puddings and yogurts,
- . cereal boxes (as least a reduction in size to achieve a better product to air ratio),
- . many cosmetics,
- . toys, and
- . hardware.

Another reduction opportunity is to use dispensers rather than portion packages.

Coated papers are another area where reduction is possible. Coatings can be eliminated in some applications or made thinner as new technologies develop. Packaging can be designed for reuse by increasing durability and thereby decreasing unit requirements. Paper packaging that incorporates other materials into its production (e.g. wax paper cups, blister packs, laminated paper, meat wrappings etc.) are defined as composites in this report, although the quantities of pulp in composites are included in the overall pulp and paper figure.

Reuse

Paper packaging can only be reused if previous use(s) have not altered or dirtied it. Also paper packaging in direct food contact cannot be reused in most cases. In some instances, due to labelling, it would be logical for users and uses to remain the same. Paper quality degrades significantly when it is washed or heated, so washing processes are not an option for enhancing the reusability of this material. The Canadian Pulp and Paper Association has also indicated that the addition of tear resistant layers by laminating does not extend the reuse life of paper packaging, but only decreases its recycling potential. There are, however, many applications of paper-based packaging which do not dirty or change the package and would be suitable for reuse.

Corrugated boxes, some moulded packaging (particularly egg cartons) and envelopes are the three areas with the greatest potential for reuse.

Corrugated boxes can easily be reused, simply by returning empty flattened containers with the shipper when they arrive with new products. When the shippers receive products from the manufacturer where the goods are packaged, they could return the flattened boxes for reuse. In some cases, reuse may not be compatible with automatic or semi-automatic filling equipment. When possible, corrugated containers should be set up by relying on the inter-folding of the tabs, rather than tape, staples or glues which make it difficult to re-flatten them. Rather than printing the label directly on the box, insert folders attached to two sides could be inserted with the necessary labelling. It is suggested that corrugated reuse is most appropriate for non-fragile items and low stress applications where container performance is not crucial.

Depending on the incentives and commitment to participate in a corrugated reuse program, 30-50% of corrugated containers could be reused anywhere from two to fifteen times. Containers in too poor a condition to be reused can be extracted at the manufacturer level, centralizing the collection of old corrugated cardboard for recycling.

Some large companies, such as GM, require suppliers to take back packaging as part of their procurement policy. By institutionalizing this type of activity pattern, efficiency and effectiveness of reuse systems can be improved.

Design for reuse increases the suitability of particular packages to reuse and can increase the number of times it is reused. Design for reuse is important in meeting insurance requirements for products shipped in particular containers, such as corrugated cardboard boxes.

It may be possible in some sectors to standardize the size of containers so a particular quantity of certain sizes of containers could be returned to any one of a number of manufacturers. Standardization is discussed in more detail in Section 9.

Egg cartons could be returned to supermarkets and other venues, such as farmers markets, for reuse, as some consumers already do. Rarely are egg cartons damaged during use and

there already exists an informal network for egg carton returns. Egg cartons can be reused 15 - 20 times and such a system could achieve participation levels of 40 - 60%. In cases where labelling is considered important, the slotting label system described for corrugated cartons could be used. A cleansing process is not required because eggs have their own natural package (the shell) to protect them from contamination, so long as eggs are unbroken in the carton.

The design of heavy duty shipping envelopes has seldom received consideration for reuse. Intra office mail is one example of a form of envelopes that are designed for reuse. These envelopes are commonly used fifty times. Envelope designs employing similar concepts could be used for special service envelopes, common with courier-type delivery services.

Paper based packaging reuse potential is influenced largely by the application, as well as the nature of the package. Reuse potential for all paper products is estimated to be 15 - 25% by weight.

Recycling

All pulp based packaging is technically recyclable. Paperboard packaging discussed in this section only includes packages made of 100% pulp.

Paper packages are easily distinguished from other common packaging materials, such as plastics, aluminum and composites. Therefore, separation of paper packaging at the source results in a good quality pulp substitute. In many cases, a waste paper generator uses primarily one type of paper packaging so their waste paper arrives at the sorting plant or mill pre-sorted according to paper type. Low levels of contaminants are common in used paper packaging collected for recycling. Contaminants include low grade pulp, non-pulp material or additions/attachments to the paper packaging such as tapes, glues, and inks.

To eliminate contaminants which would degrade the quality of the paper recycled, most recycling facilities have hand-pick systems, magnetizers and/or other screening systems.

Currently, the pulp and paper industry identifies five main grades of waste paper, each with different sources and end uses. The end uses reported for each grade in Table 2.2 reflect existing applications of the various waste paper grades. Other applications are technologically available but are not commonly used today.

Decontaminated waste paper is combined with mill broke and trimmings and virgin pulp as required to produce the desired grade. 5 - 10% of raw material weight is mill broke in paper production. The paper application for which secondary fibre is directed depends on:

- the type of waste paper;
- the source (affects contamination levels);
- mill capacities and capabilities; and
- markets.

Table 2.3 outlines average applications of secondary fibre as a proportion of production broken down by packaging application. Secondary fibre used in the manufacture of paper/paperboard products may contain an average of up to 70% mill wastes.

The amount of waste paper purchased is not equivalent to the amount of pulp produced because there is a system loss of scrap, called shrinkage. Shrinkage occurs due to the removal of contaminants, short fibre elements etc. Losses can occur during the following processes:

- outthrows during sorting;
- screen rejects;
- floor slop;

Table 2.2

Waste Paper Grades, Sources and Applications

Typical Permitted Contamination Levels (%)

Source	Main Grades	Prohibitive Materials	¹ Outthrows ²	Applications
Sheets/cuttings from Converting Plants	Pulp Substitutes (unprinted white & coloured)	None	2	fine paper, tissue
Sheets/cuttings from Converting Plants	Deinking	None	2	fine paper, tissue
Old news, overissue	Newspaper (min.95%)	0.5	2	newsprint, folding cartons, paperboard insulation
Offices	Mixed	2	10	packing, packaging (boxboard), molded products
OCC, plant cuttings	Corrugated	1	5	corrugated medium, kraft towel, linerboard

Source: Pulp and Paper Manufacture -Volume 3, edited by; Hamilton, Kocurek and Leopold, published by the Joint Textbook Committee of the Paper Industry, 1987.

¹ Prohibitive materials are those non-pulp materials which, in excess of the amount allowed, make the pulp unusable for the grade specified.

² Outthrows are all papers which are unsuitable for consumption in a specified grade.

Table 2.3
Use of Mill Broke in Paper Production

<u>1983</u>	<u>% Scrap</u>
Containerboard	30
Groundwood Papers	8
Tissue and Other Machine Creped Papers	32
Folding Boxboard	63
Printing, Writing related Papers	11
Industrial Packing, Converting and Misc.	24
Construction Paper and Paperboard	36

Source: Pulp and Paper Manufacture - Volume 3, edited by Hamilton, Kocurek and Leopold, published by the Paper Industry, 1987.

- short fibre elements discharged in waste water;
and
- material solubilized during bleaching and then lost
in washing.

Shrinkage can range from 10% of bond paper to 50% of coated paper. Due to shrinkage and the unlikelihood of 100% waste paper recovery, use of wood waste or virgin chips will be unavoidable for most paper grades, and more particularly the finer papers.

Paper fibre and product changes do occur in paper recycling. The specific effects vary with the nature and extent of repulping. There is a loss of strength, especially with the first three repulpings, followed by a far more gradual loss of strength. Fibre-to-fibre binding is also diminished in the process of repulping. However, secondary fibre is superior to virgin fibre in:

- dimensional stability;
- greater opacity at the same freeness; and
- surface smoothness.

In general, after an average of seven times recycling, paper fibres become extremely short, and have no value in paper/paperboard manufacture and are discarded as 'fines' in processing. The original type of fibre and strength characteristics required of the secondary fibres dictate the number of times a fibre can be recycled. Recycling processes can impact on the extent to which fibres are shortened. For instance, brushing or hydrating fibres rather than cutting them softens the effects of recycling on paper fibres. Also, those processes which use severe chemical treatment degrade fibre strength to a greater extent than others.

Fines, the unavoidable result of recycling, are often discarded in landfill sites. Mills are concerned about being penalized indirectly for recycling through high tipping fees. Options for 'fine' management, such as composting, should be explored and integrated into waste paper management processes. Composting is already favoured as a waste management approach in many provinces and municipalities in Canada.

Summary of Estimated Paper/Paperboard 3R Opportunities

Reduction - 20 - 25% (304,000 tonnes) of corrugated cardboard by changing regulations and decreasing strengths (weight) used where possible. 5% (44,000 tonnes) - other lightweighting of containerboard where possible. 5% (44,000 tonnes) - elimination of 'outer shell' where possible. Total 14% (392,000) tonnes.

Reuse - 30% (456,000 tonnes) corrugated cardboard. 40 - 60% egg cartons, heavy duty envelopes. Total 15 - 25% (563,000 tonnes).

Recycling - 80% (2,252,800 tonnes)

Some paper will be contaminated so it will not be suitable for recycling, also, it is only possible to recycle paper fibres an average of 7 times.

3.0 STEEL

Approximately 380,000 tonnes of Canadian steel are currently used in packaging applications. By far the most significant packaging application of Canadian steel is in food containers. Beverage containers and industrial packaging are also manufactured using Canadian steel, as illustrated in Figure 3-1.

Tin mill products and cold rolled steel (no casting) make up the majority of steel used by the packaging industry. Generally speaking, tin mill products are used to manufacture food, beverage and other consumer sized containers. Cold roll steel is employed in producing industrial containers, see Figure 3-2 and Table 3.1.

In addition to Canadian production, trade in steel containers is projected to amount to a net import of \$60 million worth of empty steel containers into Canada in 1989. It has not been possible, to date, to estimate the tonnage of material this represents. Some imported steel cans are made according to standards which vary from ours, and may contain lead, etc.

Growth in steel packaging is projected to be marginal over the next decade. It is unlikely to exceed 0.5 percent per year, see Table 3.2.

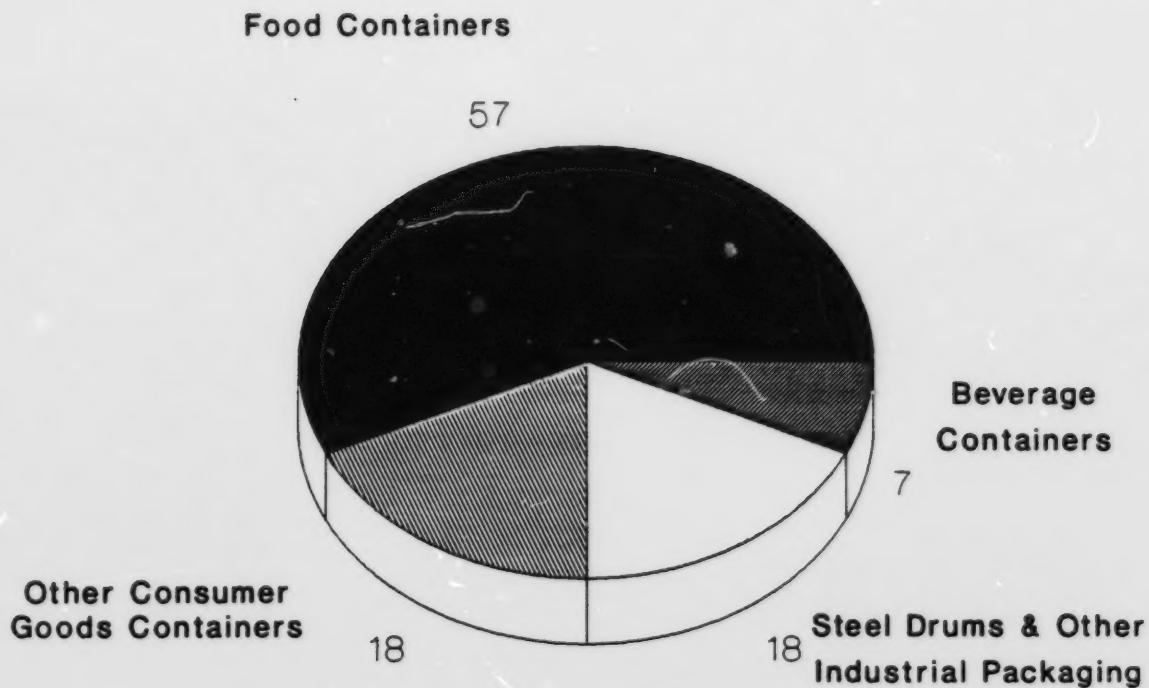
Recycling of steel containers currently amounts to an estimated 7.5 percent of Canadian production with most being recycled in Ontario. The industry has confirmed that 100 percent recycling of steel containers is technically feasible.

Drums can be reconditioned for reuse. At the end of their serviceable life, they can be scraped and shipped to steelmakers for remelting. Data is unavailable on the amount of drums currently being managed in this way.

Figure 3-1

Application of Canadian Steel by Packaging Industry (1988 estimate)

(Values as a %)

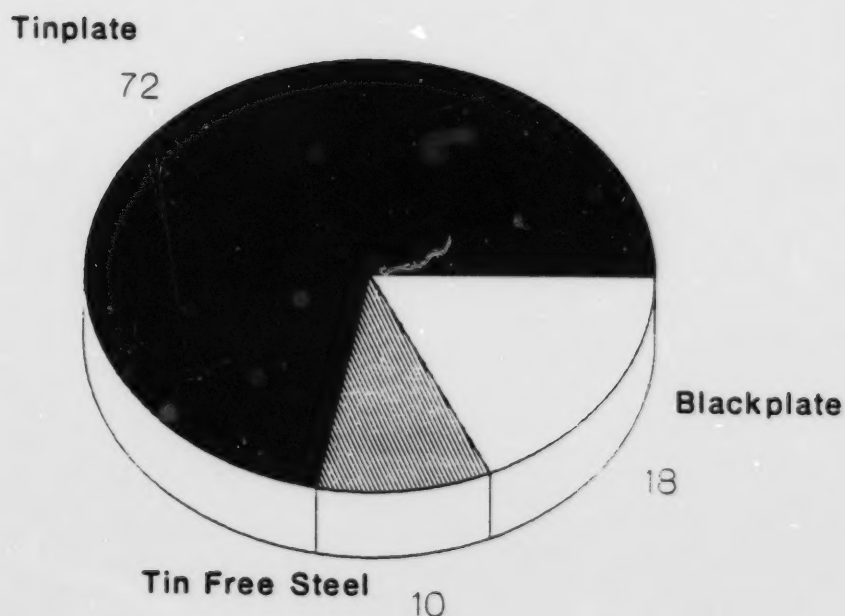


Total tonnage of steel used in Canadian packaging industry estimated to be 380,000 tonnes, or 4.5% of Canadian steel production (exclusive of specialty steels).

Estimated 7% recycled exclusive of drum recycling.

Source: Canadian Tinsplate Recycling Council

Figure 3-2
Use of Canadian Steel By Canadian
Packaging Industry (1988 estimate)
(Values as a %)



Total tonnage of steel used in Canadian Packaging estimated to be 380,000 tonnes, or 4.5% of Canadian steel production. Amount recycled: estimated at 7 %, exclusive of drum recycling.

Source: Canadian Tinplate Recycling Council

Tablel 3.1

STEEL USAGE BY CONTAINER MANUFACTURERS - 1988

<u>Consumer Containers:</u>	<u>Tonnes</u>
Food Containers (including Juice)	218,000
Other Beverage Containers	25,000
Other Consumer Goods Containers (including Aerosols)	69,000
<u>Industrial Containers:</u>	<u>68,000</u>
Total Container	380,000
 TOTAL CANADIAN STEEL PRODUCTION (1988)	 8,400,000

Source: Canadian Tinplate Recycling Council

Table 3.2

Projected Growth of Canadian Steel Container Applications

(tonnes)

<u>Year</u>	<u>Amount</u> ^(1,2)
1988	380,000
1991	386,000
1994	392,000
1997	397,000
2000	403,000

Note:

¹⁾ Net import of steel packaging valued at \$60 million is projected for 1989 by Statistics Canada; it has not been possible to date to convert this to a tonnage figure. The impact of trade in steel packaging is not included in the above data.

²⁾ Growth assumed at 0.5 percent annually

Source: Canadian Tinplate Recycling Council

3.1 Overview of Steel Packaging Production

Steel is produced (usually in a blast furnace) from pig iron which is produced from iron ore. The combustion of coke, a clean, baked, porous coal, to produce carbon monoxide results in the reduction of iron ore to iron. Fluxing of silica and alumina in the ore (preferably less than 4%) and coke ash with limestone forms slag. The reheated air which makes these reactions possible is about 2000 degrees Fahrenheit.

The molten pig iron is tapped to a transfer ladle and delivered to the steel making plant. The slag is used for concrete aggregate, railroad ballast, soil conditioner or landfill.

The conversion of pig iron, direct-reduced iron, scrap, or mixtures of these produces steel in a refining process that lowers the carbon and silicon content and removes impurities (mainly phosphorus and sulphur). The open-hearth process involves the heating of a shallow bath of metal over a flame. These furnaces were the most common until 1969 when the electric arc furnace became popular.

Some steel packaging, such as drums and cans, are made from tinplate which is produced in a continuous process of electrolytic deposition of a tin layer onto cold-rolled sheet steel. The sheet is reheated to fuse the coating and produce a metallic lustre. The tin layer is only tens of a millionth of an inch in thickness. Cans and other packaging products are produced from the rolled steel in a number of different forming processes.

There are synthetic resin bases and coatings available which replace tin. One process involves replacing the tin coating with one of chromium. The coating is applied electrolytically, is thinner than the tin layer and lacquered to render it suitable for certain food and beverage containers.

The production of steel is becoming decreasingly labour intensive, with employment between 1973 and 1984 dropping by half despite increases in production. Container production accounts for 4.5% of steel production applications.

When scrap is collected, large items are densified with shears and all scrap further densified in hydraulic presses and baled into dense cubes.

3.2 3R Opportunities

Reduction

Since 1970, cans have been reduced in weight by 30%. Steel is increasingly being produced in better qualities, improving strength to weight ratios. The process of forming cans from rolls of steel has also been improved. Cans are now made without welding the centre piece together and the steel varies in thickness, depending on the strength levels required in certain parts of the can. Although methods of achieving further lightweighting results are still being sought, projections for further reductions are minimal due to the need to maintain existing container durability and integrity, which cannot be compromised.

Steel drums are built of the gage required to provide the appropriate strength for transporting and sorting relatively large quantities of materials, both solids and liquids. Little opportunity for reduction has been identified.

Reuse

Steel cans used for food and beverage packaging cannot be reused due to potential contamination and due to its design as a one-way container. 57% of can applications are for food and 7% are for beverage containers, which can not be reused.

Reconditioning of steel drums for reuse has been a common activity for many years. Reconditioners scrub and clean used drums to free them of contaminants present in the drums from past users, thereby making them acceptable for reuse. There has been some concern on the part of reconditioners regarding their liability in the event that unknown lethal or hazardous substances are released in the reconditioning process or that these substances

are inadvertently transferred to the next user.

The issue can partially be resolved by organizing the system such that steel drum users be responsible for the reconditioning and reuse of their own drums in a direct, accountable manner. They could still hire a reconditioner to refurbish their drums, but they would be the ones to reuse them. The reconditioner would have to be fully aware of the previous uses for the drums, provided in a signed statement from the company.

Another potential area for steel container reuse are the folding steel rack containers that are being developed which are designed for durability and efficient return for reuse. These containers serve the same purpose as corrugated cardboard boxes, although they can hold up to 4,000 pounds. These folding containers only take up 25% of their set-up size when folded and can be equipped with wheels. Some steel racks are already used in some applications, such as bread distribution, and are easily reused.

Recycling

All steel packaging materials including tinplate, can be easily recycled in a closed loop process. Steel produced from scrap can be safely made into cans for food and beverages, as well as all other applications for steel packaging. Steel can be easily separated from other materials by magnets, making it the most easily separated material. Also, there is no need for segregation within the steel sector, all steel collected for recycling is recycled in the same process. The simple separation of steel from other materials and the ability to recycle all steel in a single, proven process for which there are strong, end-use markets makes it one of the most easily recycled of materials.

Most steel packaging for consumer applications (food and beverage containers) use tinplate which contains 0.18% tin. No technological problems have been encountered in using this scrap directly in the steel manufacturing process, largely because it represents a small proportion of the steel being produced. Overall, no more than 0.06% of tin is desirable in the steel making process.

There are technological processes which effectively reduce the tin content of steel if it becomes necessary to do so. One common method is the electrolytic removal of tin using stannous fluoborate-fluoboric acid. This process drops the tin content of scrap tinplate from 0.18% to 0.017% by weight. Due to the high value of tin, once higher recycling rates are achieved in Canada, it could become economically desirable to separate tin from steel.

If detinned, close to 100% scrap can be used in reprocessing. Without detinning, tinplate must be diluted with blast furnace pig iron or clean scrap in a 10:1 ratio in order to avoid cracking in hot rolled steel products. Material in industrial applications contains no tin. Seventy-two percent of steel packaging is manufactured from tin plate.

A recycling program for paint and related material containers would complement the growth of household hazardous waste diversion programs. In these programs, residents are encouraged to bring leftover materials and their containers which have the potential to be harmful in landfill sites or incinerators to a collection point. Paint is the most common material received at the collection facilities set up to accept these wastes. Some onus could also be placed on stores that sell paint to play a role in the collection of containers for reuse.

Summary of Estimated Steel 3R Opportunities

Reduction - about 5% (19,000 tonnes) - through lightweighting and thinwalling.

Reuse - 15% (57,000 tonnes of drums can be reused although some would be too contaminated for reuse); folding steel rack contains can be used as a substitute for disposable shipping boxes. Total 15% (57,000 tonnes).

Recycling - 100% (380,000 tonnes) - all steel packages are recyclable.



4.0 ALUMINUM

Aluminum has two principal applications as a packaging material beverage containers and foil. It is also used in lesser quantities for container closures.

In 1988, the size of the aluminum can market in Canada was estimated at 50,000 tonnes; the size of aluminum foil market is 23,000 tonnes; the size of the closure market was estimated at 2,000 - 3,000 tonnes. This is illustrated in Figure 4-1.

Aluminum cans are used to package soft drinks, beer, fruit juices and foods (5 - 10% of production). Foil is used in rigid containers, such as disposable baking trays and ash trays, and as a flexible wrap in household applications, cigarette packaging, beer labels and other applications.

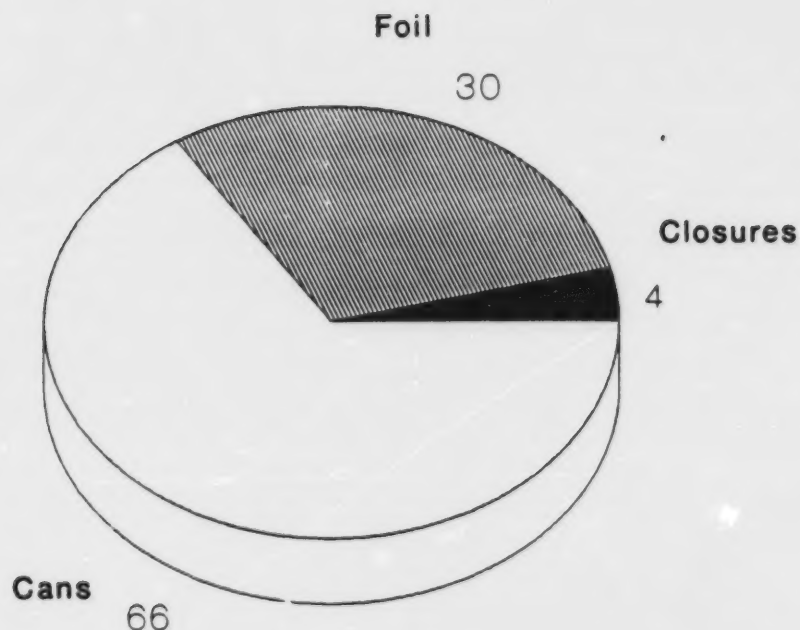
Table 4.1 presents data for aluminum packaging and the projected growth of the aluminum market to 2000. Growth is projected on the basis of foil application increasing at 1.5 percent per year and aluminum can and closure growth averaging 8 percent per year.

4.1 Overview of Aluminum Packaging Production

Aluminum is produced in electrolytic cells through the reduction of aluminum oxide, which is refined from impure hydrated alumina found in bauxite ore. Although there are alternative sources, bauxite is the ore from which aluminum is most commonly extracted. The process, patented by Karl Bayer, is extremely energy intensive.

The basic process of extracting the aluminum from the bauxite involves applying caustic leach to the bauxite at high temperature (220-550°F) and pressure (60-1000 p.s.i.) for up to 5 hours. After cooling to the atmospheric boiling temperature, the alumina in the solution is clarified by filtration and placed in precipitating tanks. The alumina is precipitated, separated by sedimentation or filtration and washed. The spent leach is recycled.

Figure 4-1
Canadian Aluminum Packaging Market -1988
(Values as a % of the total)



**Total Canadian market for aluminum packaging in 1988:
75,500 tonnes.**

**Amount recycled: 25,000 tonnes, or 33% of Canadian
aluminum packaging.**

Sources: Alcan and Reynolds Aluminum

Table 4.1

Estimated Use of Aluminum Packaging in Canada ⁽¹⁾

(tonnes)

	Aluminum Cans ⁽²⁾	Aluminum Foil	Total
1988	53,000	23,000	76,000
1991	66,000	24,000	90,000
1994	83,000	25,000	108,000
1997	105,000	26,000	131,000
2000	132,000	27,000	159,000

Note:

⁽¹⁾ Annual growth rate assumed to be 8 percent for cans and 1.5 percent for foil.

⁽²⁾ Aluminum can category includes closures.

Sources: Growth rates based on information from Alcan and Reynolds Aluminum.

At an optimum temperature of 950-985°C, primary aluminum is produced by the reduction of alumina by electrolysis into a molten bath of cryolite. Molten aluminum is removed from the bottom of the cell.

In scrap processing, contaminants in only very small amounts can be tolerated. Stainless steel is of particular concern as a contaminant because it cannot be separated visually or magnetically, and it dissolves more readily than steel. Scrap is melted in gas or oil-fired reverberatory furnaces of 30,000 - 100,000 pounds capacity. Central to the refining process is the removal of magnesium by treating the molten metal with chlorine or other fluxes.

Containers such as cans and foil equal 28% of total demand, of which cans are 80%. Used aluminum cans are the largest single source of old aluminum scrap.

Aluminum is inherently highly recyclable as a result of proven technology, favourable economics, the aluminum industry's need for metal units to be returned and high consumer awareness. Industry reports that 45 percent of aluminum cans sold in Canada are currently recycled. As compared to product manufacture using virgin materials, energy requirements are reduced by up to at least 90 percent when the incorporation of secondary aluminum into new product manufacture is maximized.

4.2 3R Opportunities

Reduction

Aluminum is a relatively light material, generally one-third the weight of steel. Foil, which represents 30% of aluminum packaging, is gaged according to strength requirement, and no advancements in strength to weight ratios are anticipated, hence no technological reductions in foil weights are predicted.

Beverage cans, which account for 66% of aluminum packaging applications, are designed for efficiency of transportation and are therefore generally filled to capacity, negating the

possibilities of non-technological reduction in this application.

Small reductions could be realized by offering the choice of larger container sizes, but it is unlikely the current size is significantly different from desired single serving requirements. One exception might be with beer, an industry which has already responded by offering the option of larger size cans for some brands, but opportunity in this area is extremely limited. Aluminum cans are non-resealable so they are unsuitable for multi-serving applications, unlike, for instance, bottles, which can be reclosed. They are approaching their technological lightweighting potential.

Reuse

No procedure for the reuse of aluminum closures, foil or cans has been established. Currently, no reuse potential for aluminum exists.

Recycling

Recycled aluminum cans are indistinguishable from aluminum produced from bauxite ore. Closed loop recycling is possible because there is no quality difference between aluminum produced from scrap and that produced from virgin materials. Also, due to the nature of the process, there is no threat of contamination. Aluminum beverage cans are 100% recyclable and can be made from 100% recyclable material. As a result, the long term market for aluminum is very secure.

The recycling process includes use of magnets, screens and gravitational separation to remove contaminants such as aluminum closures (a different grade of aluminum), foil, license plates, cast iron, zinc die castings, paper, old corrugated cardboard, wood, plastic, stainless steel and other contaminants. Contaminants are usually 0.2% by weight, with the average composition of contaminants being:

- steel cans - 0.6%

- sand/gravel - 0.09%
- plastic, paper, cigarettes - 0.02%
- others - 0.03%.

This compositional breakdown does not include volatiles and combustibles which are typically:

- paint and sealings - 2.6%
- organic residues - 0.3%
- water - 1-2%.

Air emission control expenses rise dramatically with contaminant levels that are higher than this.

The recycling process typically involves:

- mechanical shredding/crushing of individual cans to expose the interior lacquered surface;
- delacquering of shredded cans at 500°C to burn off residual solvents in lacquer and coatings; and
- charging and melting of shredded/delacquered aluminum.

During the process, there is an 8 - 20% weight loss due to oxidation of some of the aluminum. In the production of aluminum, system losses of 15 - 25% are not uncommon, so the loss experienced during recycling is not atypical.

Foil is a different grade of aluminum and cannot be readily absorbed into the existing aluminum recycling process. Contaminants, such as food, adhere very tightly to foil and the foil often rips more readily than the contaminants will be removed. 40% of foil applications are

in composite packaging which can rarely be integrated into a closed loop recycling process.

Secondary recycling processes, such as the production of construction materials, can accept small quantities of foil or composite packaging for integration into their recycling processes. Foil can also be recycled, but it is a process which is separate from can recycling and has only been successful on a small scale in the United States. Closures do not fit well into either recycling process. At present, the primary barrier to foil recycling appears to be related to intermediate processing (e.g. separation from other materials collected for recycling).

Summary of Estimated Aluminium 3R Opportunities

Reduction - 5% (19,000 tonnes) - potential reduction through thinwalling.

Reuse - 0% - no potential exists for aluminum packages.

Recycling - 66% - cans; 20% - foil (if potential is developed i.e. infrastructure provided). Total 80% (60,400 tonnes).



5.0 PLASTICS

An estimated 823,000 tonnes of plastics packaging was manufactured in Canada in 1988. Figure 5-1 identifies the applications of this packaging. Six resin types account for 98 percent of plastics packaging, as indicated in Figure 5-2. High density and low density polyethylene comprises over 70 percent of plastics packaging.

Both imports and exports of plastics packaging are projected to approach a value of \$250 million in 1989, with the value of imports being marginally higher than that of exports. It has not been possible to date to estimate the quantity (tonnage) of trade in plastics packaging, but it appears the net impact of trade on quantities of plastics packaging in Canada is minor and has been assumed to be zero.

Overall growth in plastics packaging tonnage in Canada is estimated at 6.8 percent annually in the 1986 - 1991 period, 6.1 percent annually in the 1991 - 1996 period and 5.5 percent annually over the balance of the century. Projected growth of plastics packaging is shown in Table 5.1.

The recycling of industrial plastics scrap in Canada has been undertaken for many years and is widespread. However, the recycling of post-use plastics packaging has been extremely limited. Initiatives to recycle plastic beverage bottles and, this year, a wide variety of other plastics packaging suggest that plastics packaging recycling is now undergoing the rapid growth that has been forecast for some years.

5.1 Overview of Plastics Packaging Production

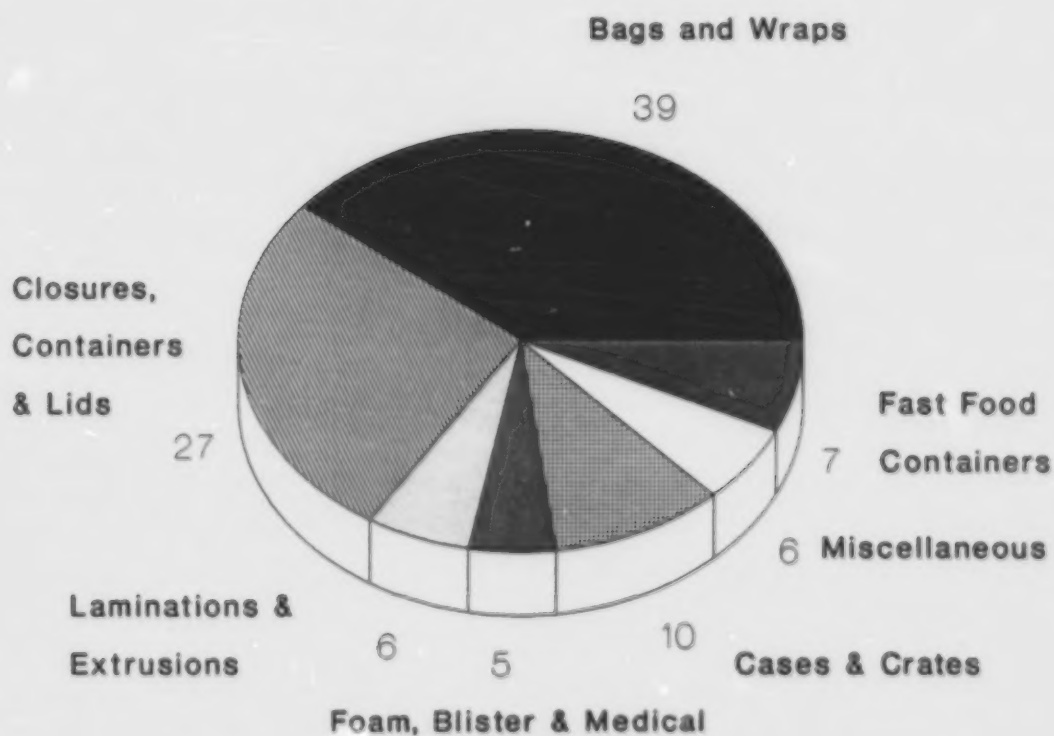
Plastics packaging production involves the transformation of crude petroleum and natural gas into one of many kinds of plastic polymer resins, which are then converted to plastics. The chemical industry, using complex synthesis reactions in closed loop systems, produces the resins from the petrochemicals and natural gas. The plastics processing industry buys the resins it requires from the chemical manufacturers and then converts it to the plastic

Figure 5-1

Estimated Application of Canadian Plastics

Resin By Packaging Industry - 1988

(Values as a %)



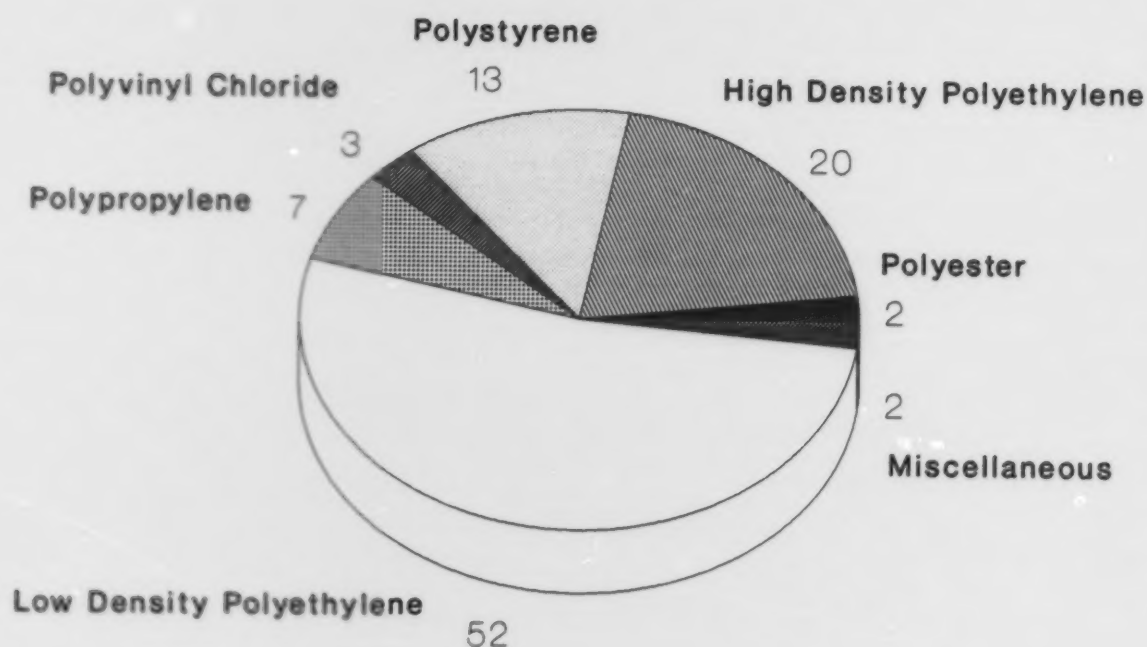
Total tonnage of plastics resin used in packaging industry estimated to be 823,000 tonnes, or 39% of Canadian plastics resin production.

Amount recycled estimated to be less than 2%.

Source: Society of the Plastics Industry of Canada.

Figure 5-2
Use of Plastics by Canadian Packaging
Industry by Resin Type - 1988

(Values as a %)



Total Canadian plastics resin consumption by Canadian packaging industry: 823,000 tonnes, or 39% of Canadian plastics resin consumption. Amount recycled: less than 2%.
Source: Society of the Plastics Industry of Canada

Table 5.1

Projected Growth of Plastics Packaging in Canada

(tonnes)

<u>Year</u>	<u>Amount⁽¹⁾</u>
1988	823,000
1991	1,003,000
1994	1,198,000
1997	1,420,000
2000	1,667,000

Note:

¹⁾ Imports of plastics packaging approaching \$250 million are projected to exceed exports by \$14.7 million in 1989. In the absence of information on the tonnage of material this represents, and in recognition of a small difference in the value of imports and exports of plastics, it is assumed that the net effect of plastics packaging trade on plastics packaging tonnage in Canada are zero.

²⁾ Annual tonnage growth of plastics packaging projected by the Society of the Plastics Industry of Canada to be 6.8 percent until 1991, and 6.1 percent until 1996. A growth rate of 5.5 percent annually is then assumed until 2000.

product it requires.

The four main activities of plastics processing are:

- **compounding** - creating the specific resin and its associated requirements;
- **converting** - transforming the resin compound into a finished product, commonly by extrusion, injection moulding, thermoforming or blow moulding;
- **finishing** - the plastic product (package) is decorated, printed, cut etc. in preparation for market distribution; and
- **scrap recycling** - plastic scrap created while converting or finishing is prepared for input back into processing.

Plastics used for packaging are almost exclusively thermoplastics which are converted by heating, forming and cooling. Thermoplastics are recyclable because they can be repeatedly reheated, melted and reformed. Thermosets, which are rarely used in packaging, are not recyclable; they do not remelt and reform readily like thermoplastics.

5.2 3R Opportunities

Reduction

Plastics are a packaging material that are inherently strong, light and thin. There are about six main plastics (each with subgroups) which are commonly used in packaging, each with specific characteristics, gaining popularity for use in very specific applications. In some instances, weight reductions can be achieved by interchanging among different plastics and/or grades therein. Differences in weight do occur between low density and high density plastics, as well as among the different kinds of plastics.

Lightweighting of plastic packages has achieved reduction in plastic packages of up to 50% since 1970. Due to the emphasis placed on lightweighting, plastic packages have almost approached their technological lightweighting potential.

The transformation of disposable plastic packaging into reusable packaging (e.g. foam peanuts) is feasible. Food and beverage container reuse is limited by health and safety considerations. Polyethylene, both high and low density, is often used for a single trip and it accounts for 70% of plastics packaging. Polyethylene non-food packaging applications have a high potential to be designed for reuse, thereby achieving reduction, for example bins and crates.

Printed plastics eliminate the need for paper labels on plastics packaging. Common existing applications for printed plastics include shampoo bottles and dairy products. Eliminating the paper labels is also positive for recycling by reducing paper contamination in the process.

Opportunities for reduction in plastics packaging are almost as diverse as their applications. Some examples of reduction opportunities include:

- use of closed dispensers rather than portion packages (e.g. ketchup, vinegar);
- elimination of the outer plastic wrap layer where it serves little additional protection (e.g. joining 3 soaps together, photo albums, coconuts, books, utensils, hardware items, pallets);
- replacing disposable plastic shopping bags with durable plastic bags, whether they be plastic or otherwise; and
- reducing the gauge of plastic films used in bags and pouches, as technology allows.

The use of plastics in packaging applications has grown rapidly in recent years, and this growth is projected to continue over the next decade. In part, growth of plastics packaging has occurred as plastic film, wraps and other products have been substituted for traditional, heavier materials such as cardboard and boxboard.

Reuse

For many applications, designing a package and system for reuse may be feasible. By reusing packaging, reduction is achieved by lessening the quantity of containers required.

One opportunity for this is cases and crates, which comprise 10% of plastics packaging. More of these applications could be designed for reuse by using a strong plastic that is not sensitive to temperature fluctuations and is not brittle; an example is the plastic milk crate. Crates, which enhance transportation economics, can be designed so that they fold flat after use or are nestable.

Pesticide containers, which some farmers "open-burn" in agricultural areas, could be designed for reuse as well, subject to toxicity and animal safety considerations. The pesticides could be distributed through dispenser systems or returned to the manufacturer, so the same containers (in good condition) can simply be refilled with the same product as required. Ciba-Geigy has recently announced the introduction of reusable pesticide containers.

In the fast food sector, eat-in customers could eat from reusables. Packaging for the take-out customers could be designed for recyclability. Fast food containers and cutlery represent 7% of all plastics packaging. All fast food packaging accounts for less than one percent by weight of all solid waste in Canada.

Food and beverage plastic packages are sometimes reused on an adhoc basis by consumers at bulk stores, natural food stores and some supermarkets. Due to the possible absorption of food materials into plastic, the growth of this informal reuse system into a formal

management system cannot be promoted. It is not technologically possible to remove contaminants if they have been absorbed into the plastic, so adherence to health standards would be questioned. Reuse systems for food and beverage plastic package applications, given today's technologies, require washing in hot water in which the plastics may change shape or otherwise deteriorate.

Plastic containers not used in food and beverage applications, such as household cleaners, can be rinsed and reused, either through a system using pouches or bringing the container to a store where there is a dispenser system.

Recycling

Each of the six main types of plastics commonly used in packaging is technically recyclable at the primary level - provided that the plastics are segregated according to plastic type, free of major contaminants and recycled separately. Single resin containers simplify plastics recycling if it is to be used for a primary product (i.e. the recycled plastic can be used to make the item which it was originally or product of equivalent value). Plastic resins, even though it is difficult for a layman to distinguish among them, have properties that are not compatible during the recycling process.

Other materials, such as glass and paper, are similar in that only certain grades are compatible in recycling to produce a high quality recycled material. Plastics packaging recycling is faced with increased technical difficulties due to the wide array of resin types specifically used in packaging. In an attempt to overcome the challenge of separating plastics packaging according to resin type, a coding system is being implemented voluntarily by industry for rigid and now, film, plastic packaging. The recycling loop and corresponding resin identification initials and code number are indicated on the packaging. Systems are also being developed whereby some mixed plastic resins can be sorted mechanically; such systems have already been introduced in Quebec and Ontario, and have also been under development in Alberta.

If other plastics become commercial as packaging materials, they may further complicate

plastics recycling. The impact of plastics packaging recycling will depend on how the growth is managed e.g. whether recyclability is a strong factor in designing new plastic packages. Plastics separated according to resin type are granulated, cleaned and repelletized to form a plastic similar to that of the original resin. Recycled plastics may not be as clear as virgin resin, could be brittle or otherwise slightly uncharacteristic of the virgin resin, and may contain unknown residual contaminants. Due to the presence of residual contaminants, recycled plastic containers may not be suitable for direct contact food and beverage applications. Using printed plastics rather than labels simplifies the recycling process.

Secondary recycling of plastics packaging is significantly simpler than primary recycling. In secondary plastics recycling, a single resin may be recycled but not used for its original application (as with food and beverage containers), although quality is usually retained at a high level, or a co-mingled process may be used to produce durable products, most commonly construction materials.

In co-mingled plastics recycling, little sorting or cleaning is required, but the resulting plastics are degraded in quality. Co-mingled plastics recycling does not represent closed loop recycling. Superwood and Recycloplast are two of the more commonly known processes where the concept is used. Inputs into the Superwood process can vary significantly, the 50% permissible contamination level attests to this. Although the Recycloplast process can use all plastics, 50% of the system inputs must be polyethylene.

Summary of Estimated Plastics 3R Potential

Reduction - example opportunities include eliminating paper labels by printing directly on plastic; use of dispensers rather than portion packages; design for reuse e.g. shopping bags; elimination of outer plastic wrapping layer where possible; lightweighting and thinwalling. Approximately 5 - 15% (41,000 - 123,450 tonnes).

Reuse - example opportunities include durable/reusable containers in all eat-in restaurants; cases and crates; pesticide containers. Total 15% (123,450 tonnes).

Recycling - 50% (412,000 tonnes) - some plastics are not recyclable, or are process sensitive to contamination, or face an uncertain market situation as secondary materials.

6.0 GLASS

In 1988, Canadian glass container production amounted to an estimated 734,700 tonnes, of which 58 percent was flint (clear), 23 percent green, 17 percent amber and 2 percent miscellaneous, see Figure 6-1.

Figure 6-2 identifies the application of glass containers in 1988. Sixty percent of glass containers in Canada, were used for beverages in that year while food applications accounted for most remaining glass containers. The percentage of glass containers used by the beverage sectors in 1988 is inflated because of widespread changes in beer bottle formats in that year.

Table 6.1 presents data on the import/export of glass containers, as well as Canadian glass container production. The Canadian industry experiences strong competition from other container products as well as from the United States and European glass companies.

The industry estimates growth in the glass container market in the 1 - 2 percent per year range. This nominal growth is primarily due to the projected increase in imports of containers or filled products as a result of free trade. An annual growth rate of 1.0 percent is assumed for the purpose of this study. While this is at the conservative end of industry estimates, it is more optimistic than the expectations of some industry observers who anticipate relative decline in the glass container market over the next decade. The size of the Canadian glass container market is forecast in Table 6.1 on the basis of this annual growth assumption.

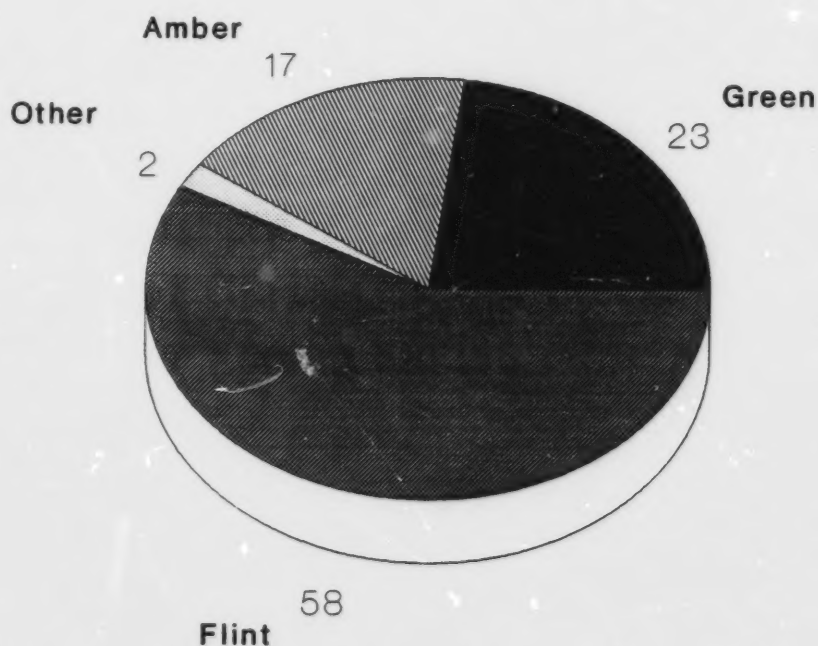
The industry estimates that imports of glass containers as either a product or as packaging-in-use amounts to 15 - 20 percent of Canadian production. It is estimated that imports of glass containers as a product amount to 7.5 percent of Canadian production, and that imports of glass containers as packaging-in-use amount to 12.5 percent of Canadian production, or 92,000 tonnes per year. This is largely attributable to the importation of wine and liquor.

The goal of the industry is to achieve a 50 percent recycling rate by 2000. The industry

Figure 6-1

Use of Glass Colours by Canadian Packaging Industry - 1988

(Values as a %)



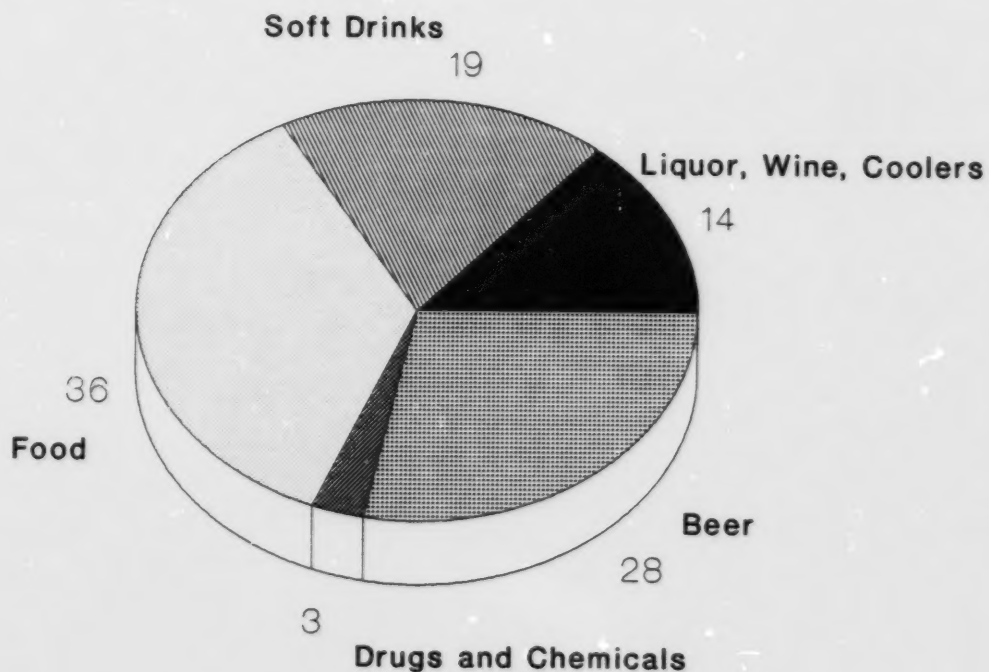
Total tonnage of glass used in Canadian packaging industry estimated to be 735,000 tonnes.

Source: Consumers Glass

Figure 6-2

Application of Glass By Canadian Packaging Industry - 1988

(Values as a %)



Total tonnage of glass used in Canadian packaging industry estimated to be 735,000 tonnes.

Amount of post-consumer recycled: est. to be 20.6% of Canadian production.

Source: Consumers Glass

Table 6.1

Estimated Use of Glass Packaging in Canada
(tonnes)

	<u>Canadian Production of Glass Packaging ⁽¹⁾</u>	<u>Export of Non-Filled Glass Packaging Product ⁽²⁾</u>	<u>Imports of Non-Filled Glass Packaging Product ⁽³⁾</u>	<u>Net Use of Glass Packaging in Canada ⁽⁴⁾</u>
1988	735,000	55,000	58,000	735,000
1991				757,000
1994				779,000
1997				803,000
2000				827,000

Sources:⁽¹⁾ Consumers Glass, personal communication⁽²⁾ Consumers Glass, personal communication⁽³⁾ Consumers Glass, personal communication; and Statistics Canada, Imports by Commodity (Cat. No. 65-004)⁽⁴⁾ Growth rate assumed to be 1.0% per year based on discussion with Consumers Glass and Resource Recycling March/April, 1989.Note: Import/export of filled containers is not included in this table.

estimates it recycled 152,000 tonnes of post-consumer cullet (used glass containers) in 1988, or 20.6 percent of Canadian production. This is identified regionally in Table 6.2. The industry also recycles its internal cullet. Overall cullet usage (internally generated plus post-consumer) amounts to about 30% of Canadian production.

In Ontario the industry has identified that the mixed colour cullet that it receives from curbside recycling programs is a significant barrier to attaining its 50 percent recycling objective. In order to encourage greater colour separation of cullet, the industry offers a differential in the price between what it pays for mixed and colour separated cullet.

Importation of cullet is minimal in most parts of Canada. Imports of cullet into Ontario from the U.S. have declined by almost 70 percent since the mid-1980's as post-consumer glass container recovery has increased. Cullet importation will continue to decrease as local markets grow and reach their potential.

6.1 Overview of Glass Packaging Production

The production of glass containers involves four main procedures: melting, shaping or forming, annealing and finishing. The raw materials are silica-sand (70 - 74%), limestone (8 - 13%), soda ash (13 - 18%) and less than 10% of other materials. Cullet can replace these materials in the batch, and historically accounts for 20 - 30% of process input in Canadian production.

The forming operation requires glass which has a high degree of thermal and chemical homogeneity, and is therefore sensitive to contaminants. After forming and annealing, the glass containers are exhaustively checked for quality and all imperfect containers are culled. This cullet, which accounts for about 10% of production, is reused in the manufacturing process.

In the manufacture of glass containers, raw materials are mixed with cullet, fed into the furnace and melted at a temperature of approximately 2750°F in a gas-fired port regenerative furnace. The glass moves into the distribution chamber when completely melted. The molten glass

Table 6.2

Use of Container Cullet in Canada - Preliminary Estimates 1988 ⁽¹⁾

(tons)

<u>Region</u>	<u>Colour</u>	<u>Usage</u> (tons)
Maritimes ⁽²⁾	Flint	6,500
	Amber	0
	Green	2,000 ⁽³⁾
Quebec	Flint	26,000
	Amber	2,000
	Green	13,000
	Industrial	18,000
Ontario	Mixed Colour	65,000
	Industrial	25,000 ⁽⁴⁾
West	Colour Separated	30,000 ⁽⁵⁾
Total		<u>187,000</u>
		(168,000 tonnes)

Notes:

⁽¹⁾ All quantities are collected directly from Consumers Glass unless noted as "industrial", which indicates return of containers from an industrial customer. Data does not consider container reuse, which is substantial. There is uncertainty in the figures due to the merger of Consumers Glass and Domglass.

⁽²⁾ Quantities identified for the Maritimes includes material recovered from industry.

⁽³⁾ This represents use of Canadian cullet. An additional 15,000 tonnes of U.S. cullet was used in the Maritimes in 1988.

⁽⁴⁾ This represents use of Canadian cullet. An additional 15,000 tonnes of U.S. cullet was imported from the U.S. in 1988.

⁽⁵⁾ Breakout by colour is not currently available.

flows into the covered forehearths and then the glass forming machines. The forehearths act as a glass trough for the machines; as well, they adjust the glass to the correct temperature required to form a container.

A plunger located at the bottom of the feeder forces the glass through an orifice ring. The size of the orifice ring determines the shape of each gob. After a large pair of shears cuts the gob, it falls into the scoop and is directed into the bottom of the blank mould. At this point, a baffle swings over the top of the blank and compressed air is forced in. The gob is forced to the bottom and forms the threaded portion known as the 'finish'.

A counterblow forces air from the bottom through the finish to form half a glass container called the 'parison'. The parison is transferred from the blank mould inverting into the blow mould to form the whole container. The mould closes around the parison, a blowhead directs compressed air to force the parison to take the shape of the mould and bottom plate.

After the final blow, the mould opens and the finished container stands on the bottom plate. The container is removed by takeout tongs which grasp the bottom under the finish. The tongs place the container on a dead plate for a few seconds to set and then the container is directed onto the primary conveyor that delivers the container to an "annealing oven" known as a 'lehr'.

The lehr is a long oven which allows the glass containers to cool slowly. This process, which is called annealing, strengthens the bottles against bumps and rough handling. When the bottles leave the machine, the containers are cooled from 1050°F down to room temperature, relieving stresses in the bottle, allowing them to cool without breaking.

Various slippery coatings are applied to the containers, allowing them to travel along the conveyors without scratching or jamming up. On the line, there are various types of inspection equipment. These machines check for the inside diameter of the finish, evenness of the finish and other types of defects such as 'checks' or cracks in the glass. Lab tests are done to check the annealing lubricity and scratch resistance, capacity and the ability to withstand

thermal shock and internal pressure.

The glass containers are packed in customer cartons and put on pallets or bulk palletized onto pallets and covered in plastic shrink wrap. The packed ware is moved into the warehouse by lift trucks and shipped by truck to the customer. Warehouses are much larger in size than production areas, as glass is stored for several months.

6.2 3R Opportunities

Reduction

In the 1978 to 1988 period, the number of containers produced per unit of weight has increased 22%. By 1994, Consumers Glass intends to achieve a further 10% weight reduction in all beverage containers. In single service soft drink containers, this weight reduction will be as high as 27%. From 1987 to 1989, Consumers Glass spent \$10 million on lightweighting technology and has committed a further \$29 million to be spent by the end of 1991. The industry goal is to achieve lightweighting in the next ten years comparable to that achieved between 1978 and 1988.

The amount of glass needed per container produced is a complex function of end use bottle capacity and shape. Container design should reflect efficient shipping and material reduction needs. The value of product delivered per unit weight of glass usually increases as container size increases.

Materials packaged in glass containers usually completely fill the container, offering little opportunity to shrink the size of the containers by volume. One of the impacts of the introduction of non-returnable glass beverage containers, however, has been to reduce the amount of glass required to manufacture the container, since returnable glass containers require thicker walls. This does not necessarily offset the environmental implications of greater disposal of non-returnable glass containers.

Reuse

Glass, being an inert material that can be washed, is a packaging material that can readily be reused for most original applications.

20 - 30% of Consumers Glass production is oriented towards the 2-way (refillable) container market. Refillable glass containers are most commonly used for beer and soft drink packaging. For these items, there is an established system of deposits, bottle returns, storage, transport to originating plant by the delivery person, delivery to the bottle washing plant, cleaning, inspection and redistribution of bottles.

Glass beverage containers which are returned can be reused, on average, fifteen to twenty times in the current Canadian experience. If bottles for a certain application, such as beer or wine, are standardized, the need for sorting is minimized. The efficiency of bottle reuse is diminished when sorting processes are required.

For instance, the beer industry previously used 'stubby' bottles, which were used by all the breweries. Now, each brewery has their own bottles, and sometimes there is a distinct bottle for each specific brand. From a reuse perspective, this is not efficient; there are approximately 30 different bottles which must be sorted, even though they have same volume. Each case must be sorted by hand so the bottles can be sent back to the originating company. Although efficiency in sorting bottles has been lessened by the diversity of bottles now in use, consumers are known to have maintained beer bottle return rates at or above the 90 percent level in British Columbia, Ontario and Quebec; there is no evidence in a decline in the return rate in other provinces.

61% of glass containers produced are used in the beverage industry, where standardization and reuse of bottles have been proven to be successful. 14% of this total is the liquor, wine and coolers group, which has never had standardized containers in Canada, or been reused. In Japan, however, non-beer alcoholic beverages are sold in reusable containers. These bottles are reused an average of twenty times each.

Food applications account for 36% of glass packaging, 100% of which presently use one-way containers. The challenge with glass food packaging reuse is to devise a series of standardized containers of different sizes which are appropriate for the various foods for which it is used as a package. Such a system could be successfully organized, but because of the increased need to sort containers, efficiencies would be lower than in beverage applications. Also, health issues would have to be addressed, as would increased costs to the grocery industry if such a reuse system were to involve grocery stores in the collection/handling of the containers. The bottle washing process would be complicated by the wide variety of products for which the containers are used, unlike beverage applications where the products are relatively homogeneous.

Reuse of glass containers is cost effective. In British Columbia, the cost of a dozen one-way beer bottles is \$1.20, while given an average return rate of eight times for twist-offs, each dozen bottles costs \$0.82, incorporating high estimates for collection (\$0.30/dozen) and washing costs (\$0.30/dozen). The cost per dozen diminishes with the number of times the bottles are reused to \$0.68 per dozen if they are returned twenty times. Caustic soda is used to wash bottles. The soda is recycled a number of times until the water reaches a certain degree of contamination. The caustic soda is then completely neutralized before it is released to municipal sewers, where there is a no tolerance for unneutralized caustic soda.

Although increased glass reuse may be feasible, the future of the glass industry in Canada would be threatened if measures to increase reusability were applied on a package material basis rather than on an application specific basis. For instance, setting a reuse target of 50% for glass would make the glass industry vulnerable to substantial market share losses that could result in an overall decrease in reuse. On the other hand, if the target was to have 50% of the beverage industry using reusable packaging, the threat to the industry which reuse poses would be nullified.

Compatibility/incompatibility of reuse with the blue box system has yet to be established. It is conceivable though, that a reuse system would maximize efficiency if trucks could be adapted to take glass for reuse, as well as recyclables. For example, each truck could be rigged with a conveyor system of glass bottle holders that would transport the glass safely within the truck. Consumers would have the option of returning their bottles to the store to refund their deposit or forfeiting their refund and placing it in their blue box. The economic implications of integrating reuse systems with curbside collection recycling would need detailed evaluation, since current trends in curbside recycling are towards minimizing the handling/sorting of materials at the curb as a means of minimizing the cost of curbside collection.

Recycling

Recycled glass is produced at a premium to the cost of glass produced using virgin materials. Future improved cullet quality, however, may bring savings attributed to decreased energy demands. Containers produced from cullet have the same properties as virgin glass, and they are indistinguishable.

Problems that can be encountered in the use of cullet (scrap glass) are contaminants and mixed colours. Without colour sorting, the maximum acceptable proportion of mixed colour cullet for manufacturing, each of the three most common colours of glass are as follows:

Green - 85% (if mixed with flint, possible to use 100% cullet)

Brown - 25% maximum 25% green)

Flint (Clear) - 0%

Due to the high level of contaminants typical in mixed colour cullet, the maximum cullet usage in the manufacture of green and brown glass is 0 - 25%. Flint accounts for 58% of glass container manufacture for Canada, so these figures emphasize that high level of cullet usage in glass manufacture is dependant upon colour sorting.

With complete colour sorting and contaminant free cullet, a proportion of 80% cullet to 20% raw materials is acceptable in flint glass production. Consumers Glass, the only glass container manufacturer in Canada, has set 50% cullet usage by 2000 as a goal, but already supplies some glass packaging with much higher cullet content; for example, the Quebec Liquor Board has a contract with the company that has a minimum requirement of 76% cullet content in new wine bottles.

Ceramics, such as porcelain, whitewares and bricks are the principle contaminants in recycled cullet. Plate and sheet glass are also contaminants in the glass packaging process. Appendix A identifies specifications for glass container recycling in Quebec.

Consumers Glass reports that the main challenges in recycling have been:

- contamination in mixed colour cullet; and
- colour sorting in areas, such as Ontario, where mixed colour cullet has traditionally been undertaken.

Contamination is being decreased by educating the public, colour sorting and by beneficiation processes used to screen for contaminants. Consumers Glass operates three beneficiation facilities. The company is currently planning to expand its beneficiation facilities across the country.

Beneficiations systems are able to handle container "baggage" such as, caps, neck rings, tramp ferrous metal, and paper and plastic labels. Ceramics cannot be effectively removed. To minimize ceramics, Consumers Glass pays a premium for colour-sorted, hand-picked glass.

Summary of Estimated Glass 3R Potential

Reduction - 10% (73,500 tonnes) through lightweighting and thinwalling by 1994 and 22% by 1998.

Reuse - 30% (441,000 tonnes) -approximate current level of glass reuse as a result of reusable beverage containers. Additional technological reuse potential exists with respect to glass food packaging and existing non-reusable beverage containers.

Recycling - 75% (551,250 tonnes) - due to limitations imposed by colour.



7.0 WOOD

An estimated 794,000 tonnes of wood packaging is currently manufactured in Canada. About 90 percent of this quantity is manufactured as skids and pallets; the remaining 10 percent is comprised of wood crates, boxes and other wood packaging.

Figure 7-1 illustrates the application of wood packaging in Canada.

Wood pallets can be made from either hardwood or softwood. Hardwood pallets predominate in the consumer and grocery products sector, softwood predominates in other applications. The industry estimates that approximately 45% of the pallets in use are hardwood, and 55% are softwood. Hardwood pallets appear not to be used at all in western Canada, reflecting the scarcity of suitable hardwood tree species from which to manufacture pallets.

Trade in new wood packaging is minimal. An estimated 1 percent of Canadian production is exported, while net exports amount to only one-third of that amount. However, significant trade occurs in wood as a package-in-use; this trade is principally by way of pallets used to package automotive and other industrial products traded between Canada and the U.S.

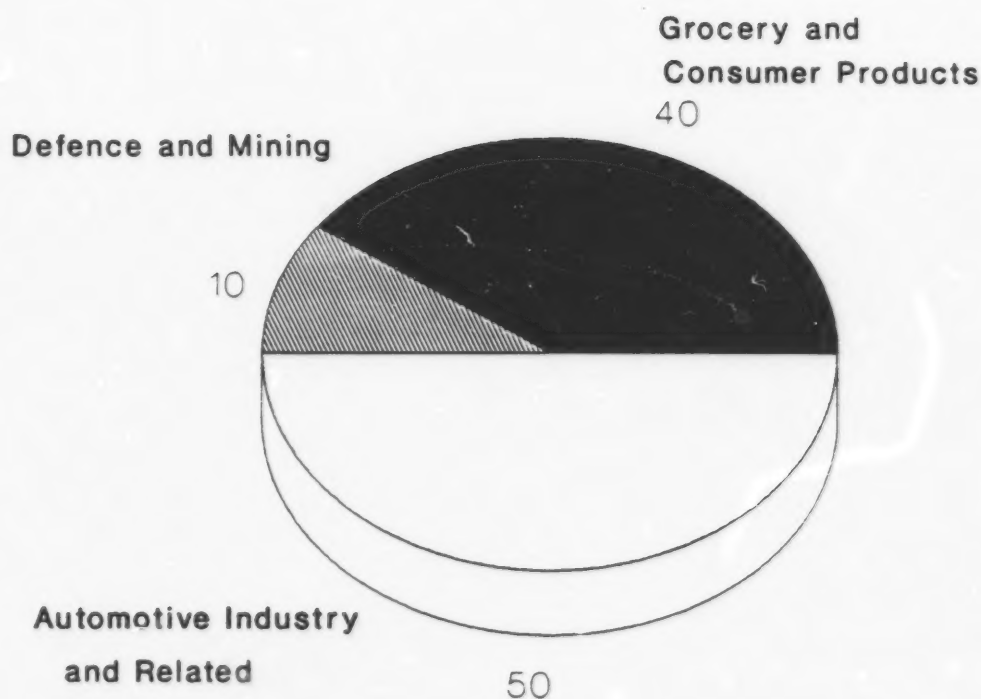
Growth is reported to have averaged 8 percent in the wood packaging industry since 1982. Slower annual growth of 5 percent is assumed for the rest of this century in recognition of new technologies providing increased competition for traditional wood packaging. Production, trade and growth of wood packaging is estimated in Table 7.1.

Pallet reuse is the norm in some applications, particularly in the grocery business where at least 2 organizations operate a reusable pallet rental service and ensure that pallets used within the system are in a reasonable state of repair.

Figure 7-1

Estimated Application of Wood by Canadian Packaging Industry (1988)

(Values as a %)



Total tonnage of wood used in Canadian packaging industry
estimated to be 794,000 tonnes

Amount recycled: estimated to be 3.3%

Source: Based on Canadian Wood Pallet & Container Assoc.

Table 7.1

Estimated Use of Wood Packaging In Canada

(tonnes)

	<u>Canadian Production Of Wood Packaging</u> ⁽¹⁾	<u>Export of Wood Packaging</u> ⁽²⁾	<u>Imports of Wood Packaging</u> ⁽³⁾	<u>Net Use of Wood Packaging in Canada</u> ⁽⁴⁾
1988	800,000	8,000	2,000	794,000
1991				917,000
1994				1,062,000
1997				1,227,000
2000				1,420,000

Notes:

¹⁾ Estimated from data provided by the Canadian Wood Pallet and Container Association (CWPCA)

²⁾ Estimated from Statistics Canada, Exports by Commodity (Cat. No. 65-004) and CWPCA

³⁾ Estimated from Statistic Canada, Imports by Commodity (Cat. No. 65-007) and CWPCA.

⁴⁾ Assume average annual growth rate of 5.0 percent

7.1 Overview of Wood Packaging Production

Wood pallet production is second only to construction in the consumption of wood in Canada. Skids and pallets account for 90% of wood packaging production. Wood is provided from the sawmill industry, who receive delimbed whole trees from primary forest industries. The whole trees are debarked and run through the sawmill, cutting the wood such that minimum waste is produced. The lumber is then cut according to specification, graded and shipped to market, which in this case is a pallet maker.

The most common pallet standard is 48" by 40", although some specific industrial sectors such as the beer industry, use different size and forms. Most hardwood pallet application is in the grocery and consumer products sector, and some are used in the industrial sector. Softwood pallets are manufactured from pine, spruce, fir or poplar; hardwood pallets are manufactured from oak, maple and beech.

In terms of application, the principle distinctions between these pallets are cost (softwood is cheaper on a simple cost per pallet basis) and strength/durability (softwood, particularly eastern softwood, is weaker and less durable). From a waste management perspective, the principle distinction is that hardwood and some western softwood pallets are designed to be reusable, whereas some western and most eastern softwood pallets are generally designed as "one-way" and are discarded following use. Only 1 in 30 softwood pallets are reused. Hardwood pallets are rare in western Canada due to the scarcity of suitable species.

Pallets are constructed according to the specifications of the client. They have traditionally been constructed by hand, but some manufacturers now depend on a more mechanized process.

New technologies are impacting on pallet construction. For instance, nail-less pallets are now being introduced to the marketplace which contain petroleum resins in the wood. These pallets, which have already been introduced in the United States and Europe, represent a threat to current opportunities which exist for the use of wood waste. Nail-less pallets are not

as durable as traditional pallets, especially because they may freeze together outside and breakage occurs in trying to separate them. When they are separated and broken, they cannot be repaired.

Pallet and wood container construction involves the use of primary wood products. Therefore, wood waste is produced in harvesting, sawmilling and pallet manufacturing. This waste cannot be recycled back into the wood packaging production process. In the production of other containers, other than composites, there is a production process to which scrap can be added. In Ontario alone, it has been estimated that the manufacture and repair of pallets results in 600,000 tonnes of wood waste annually.

Some pallets have been constructed from particle board, which can incorporate wood waste as a material, but their performance has not been satisfactory.

Hardwood pallets are estimated to account for 45% of pallet applications. It is estimated that half of pallets produced in Canada are used in the auto industry.

7.2 3R Opportunities

Reduction

Pallet design maximizes the strength ratio which can be achieved using a minimum quantity of wood. As such, the actual quantity of wood used as material inputs cannot be reduced. Layers added to wood containers in their shipment to market can be minimized because wood does not deteriorate when exposed to weather elements for short periods of time. For example, sometimes pallets are wrapped in a sheet of plastic which may not always be necessary for the appropriate application of the pallet.

There are two alternatives to pallets, both of which requires special attachments for fork lift trucks, but which use less material:

- 1) Ship Sheets. A strong sheet of paper or paperboard on which product is placed instead of a pallet. The specially equipped truck grips the edge of the paper and pulls the load onto a single side metal blade. To unload, the unit is pushed off the blade onto the floor. Very imaginatively, this is called a push-pull unit, and is starting to be used in the grocery industry. It is suited to any load which is not too heavy. Ship sheets come in narrow sizes and weights, and can be reused several times. Most can be recycled.
- 2) Clamping. Used in the grocery industry to pick up units, of shipping cases. Cases are unitized and piled directly on the floor. Fork lift trucks equipped with large clamps pick up the unit by clamping the sides. Clamping is used for relatively light loads.

Reuse

Wood pallets are rarely contaminated by the products they transport. Provided the pallet has been appropriately designed and an appropriate infrastructure is in place, reuse can be readily undertaken. Pallets are simply shipped back with an empty returning truck from a supplier and used again for the next shipment of materials. There are some formal mechanisms in place for renting pallets as well, so the responsibility for repairs can be transferred to an association to which fees are paid on a membership basis to cover the costs of repairs and maintenance.

Although pallets are generally not contaminated in use, they can be damaged. There are companies that refurbish pallets to make them suitable for reuse. The process typically requires that broken boards are removed and replaced with good boards, and the pallet is returned to the marketplace. Pallet repair is not a technically skilled industry, but a labour intensive industry characterized by low profit margins and a relatively large land requirement.

Capital requirements for pallet refurbishing are modest. The principle technology requirement is an un-nailer to disassemble pallets. Capital costs for this technology are in the range of \$15,000 - \$26,000 for a machine to process up to 3,000 pallets per week; even this can be avoided if more labour intensive approaches are used.

Hardwood pallets and reusable softwood pallets may be reused for a reported average of twelve trips without repair and can be repaired an average of 4.1 times, the total number of uses being 50. Reuse of softwood pallets is also feasible and can be optimized by conducting research to determine the effects of design alterations, such as using hardwood frames in softwood pallets.

Wooden crates can be reused in the same way as wooden pallets and skids, although they can not be returned empty as efficiently as pallets. Discussions with the industry indicate that wooden crate usage in Canada has declined over recent years, and that importation of wooden crates as packaging-in-use exceeds domestic industry usage of wooden crates. This limits the extent to which wooden crate reuse can be applied in Canada.

Recycling

Wood packaging is a very natural product, with the only additive being nails which can easily be removed in a magnetizer. The wood is usually pure and clean, and therefore technically appropriate for a number of wood uses. There are numerous markets for wood waste and used wood.

Used wooden containers can be chipped and passed over a magnetizer to remove nails using such equipment as supplied by Shred Tec and used for applications where virgin chips are consumed. Wood chips are used in the pulp and paper industry, recreational areas, chip board manufacture, and landscaping, and as bedding for livestock.

Sawdust and shavings produced in pallet manufacture and repair can be used as animal

bedding, composted (for use as potting soil, landscaping, agricultural areas etc.), and particle board.

Recycling of used wooden containers is simple technologically, collection and chipping networks should be organized so that potential users are accessible to manufacturers of all scales.

Summary of Estimated Wood 3R Opportunities

Reduction - There is virtually no potential for reduction in wood packaging.

Reuse - 85% - pallets could be reused; 5% - some wood containers could be reused. Total 90% (714,000 tonnes).

Recycling - 98% of wood packaging could be recycled once the wood is no longer suitable for wood packaging e.g. it could be used for animal bedding, compost, landscaping, pulp and paper etc.

8.0 COMPOSITES

The term "composites" refers to packaging that is composed of two or more different materials. In some cases this can be as a result of laminating one of the basic packaging types discussed above. Corrugated cardboard cartons for example, may be laminated with plastic; in a different sense, within the pallet industry hardwood and plastic coatings are being developed to extend the life of softwood pallets.

In other cases, composite packaging is manufactured from different types of the same basic material. This is increasingly common within the plastics packaging sector where plastics food packaging has been developed that combines several layers of different plastics. For example the plastic ketchup bottle is made from six layers of different plastics.

A third type of composite packaging is manufactured from two or more materials. The most well-known composite packaging of this type is the Tetra Pak package, which is made from plastics, paper and aluminum foil, the three layers forming one unit.

The total amount of composite packaging used in Canada today is unknown, but it is clearly increasing rapidly. Composite quantities that are known are as follows:

- aluminum foil - 9,000 tonnes (12% aluminum packaging);
- plastics - 51,000 tonnes (7% of plastics packaging); and
- paper - minimum 140,000 tonnes (6% of paper packaging).

Total 200,000 tonnes.

The plastics industry in particular has forecast rapid growth of plastics composite packaging for some years, since it holds the promise of lightweight packaging that can be tailored to the requirements of specific goods, using specific types of plastics. Tetra Pak, which holds 90

percent of the Canadian market for its packaging type, predicts the 15,000 tonnes of materials it and its competitors use today will grow by 10 percent a year over the next 10 years.

From a packaging user perspective, composite packaging can be attractive because of its ability to outperform traditional packaging products. Improved performance can be in terms of:

- Weight. Composite packaging is typically lighter weight and therefore requires less material to manufacture, less energy to transport, and takes up less shelf space (hence allowing more product) per unit of shelf space.
- Durability. Traditional packaging can be made more durable as a result of laminating, leading to increased reuse of the package. This is attractive in bulk and industrial packaging where the physical appearance of the package is of secondary importance.
- Versatility. By adding a protective coating, materials that have limited applications can expand their potential uses; e.g. paper can be used to contain liquids when a plastic or wax coating is applied to its outer surfaces.

Environmental concern with composite packaging has focused on the recyclability of the package. Successful recycling is based on separating materials from each other so that each material can be used as a raw material. For many composite packaging types, it is not economically, or in some cases technically, feasible to do this.

On the other hand, composite packaging can have environmental benefits through reduced demand on materials and energy.

8.1 Overview of Composite Packaging Production

The production of composite packaging involves the manufacture of the primary materials independently, and then their joining by some method, such as laminating, to produce a package.

It should be noted that the quantities of each material listed in previous sections include the materials that in later production stages become composite packages. For example, 12% of aluminum packaging is used as a component in composite packaging. Common applications of aluminum foil in composites include: creamers, yogurt and some other dairy product containers, Tetra-Pak, chip bags, and wrap around specialty cheeses.

Other common applications of composite packaging include:

- juice containers (paper and steel),
- laminated paper products,
- waxed paper wrapping,
- cookie bags (variety of papers and plastics),
- squeezable plastic bottles (multi-layers of plastic),
- paper board with plastic windows/laminates,
- milk cartons (paper and polyethylene), and
- blister packs.

Materials most commonly used in composites are plastics, paper products and aluminum. No figures on the quantities of specific types of composites are available, so 3R opportunities will be unquantifiable.

8.2 3R Opportunities

Reduction

In some composite packaging applications, it may be possible to remove one or two layers of the package without negatively affecting the product or reuse potential or increasing the gauge of the remaining materials.

Some possibilities include:

- calliper reduction;
- plastic layer from cardboard and boxboard/paperboard in some applications;
- paper layer from meat wrap; and
- paper layer from milk packaging (leave just the plastic).

Potential reduction can not be estimated because the applications and types of composites are not quantified.

Reuse

Composite packaging have little reuse potential. Often the outer layer is plastic, which cannot be reused for food or beverage applications. For some, such as blister packaging, the package must be broken to open it, eliminating reuse potential. Composite packaging varies greatly and is reuse opportunities exist in some cases. For example, laminated cardboard may be reused just like other cardboard, but reuse potential is not increased and recyclability is lost.

In summary, there may be some limited and application specific reuse potential for composite packaging, but potential is estimated at 2 - 5%.

Recycling

There are a few processes for the recycling of specific composite materials. It should be emphasized though, that each recycling process is very specific to a particular composite material and the feasibility of segregating all the different recyclable composite packages is extremely low. Often in these processes, the input materials cannot be completely separated, so impure recycled materials are produced which can only be used in secondary recycling processes, such as Superwood.

Rigid polystyrene can technically be separated from aluminum, in creamer and yogurt packages for example, to produce recyclable materials in a patented process. Polyethylene can technically be separated from cardboard (commonly used combination for milk cartons) but the process is uneconomical (even with secure, clean supplies from packaging manufacturers for end cuts) and the recycled materials are not of a high grade. Tetra-pak containers can be used in Superwood or as a raw material for the production of a special, dense particle board.

To facilitate future recycling of composite packaging materials, Tetra-Pak Inc. of Ontario will launch a small-scale recycling program in the Town of Markham, north of Toronto, beginning in June 1990. Collected through the Blue Box curbside recycling program, the Tetra-Pak cartons will be combined with other mixed plastic containers and used in superwood process to generate a durable plastic lumber product.

Summary of Estimated Composite 3R Opportunities

Reduction - removal of layers (lightweighting).

Reuse - very little reuse potential. (2 - 5%)

Recycling - secondary recycling only, for some kinds of composite packages, others are non-recyclable.

NOTE:

Tonnages estimated for packaging materials discussed in other sections of this document do not take into account the proportions of those materials used in composite packaging, although it is known that proportions of these materials are used to make composite packages.

9.0 NON MATERIAL-SPECIFIC 3R OPPORTUNITIES

The philosophy of waste reduction, reuse and recycling demands a broad-based approach to materials management that can not be critically analyzed from the narrow view of material by material opportunities. Many 3R opportunities are non-material specific and non-technological in nature. These opportunities involve general management and activity patterns which need to be viewed in terms of the whole system of which they are a part. This section describes 3R opportunities which exist in the packaging system as a whole.

Bulk/Dispensing Systems

Packaging is usually not designed for durability. Design considerations relate to product protection, transportation, shelf appearance, marketability. Packaging which is designed for durability can be readily washed and reused. The major draw-back to consumer use of durable packages for consumer reuse in the existing marketplace are:

- awkward refilling;
- risk of contamination;
- only available for a small selection of items;
- complete product information not always supplied; and
- extra step of weighing packages before filling is required.

Very little research has been directed towards developing consumer-friendly bulk/dispensing systems, although some inroads have been made on a small scale at stores in cities across Canada. The results of a couple of hours devoted to developing such a system are encouraging and indicate that responsible research in this direction could lead to a return to durable packaging in proportions that would be unthinkable without such research.

Using the example of consumer bulk foods, refilling would be simplified and the risk of contamination would be negligible if customers did not have to reach into a barrel with a large scoop and then direct the material into the durable container. To avoid this situation,

'dispensers', not barrels should be used. Dispensers have recently been developed that have on/off functions that can be used by simply placing the container under the 'tap' and allowing the product to flow into the customer's container from a completely enclosed (possible even locked) chamber. On the other hand, the introduction of bulk/dispensing systems must be sensitive to health, safety and convenience considerations if they are to compete effectively with disposable packaging.

Without question, store operations would require alteration to accommodate bulk/dispensing systems, but only a detailed study could testify as to the overall impact on staff requirements. Considerably less time would be needed for pricing, but more time might be required at the cashier. It is possible that cashier time would be minimized by the automatic dispensing of a label which specifically describes the contents of the container when the material is dispensed. These are all design considerations for which detailed research would be justified.

Currently, pricing for bulk materials is based on weight. To avoid having to weigh containers before filling (so the customer doesn't have to pay for the container), the dispenser could be capable of calculating the weight of the material dispensed, and print this on the label as well.

The primary purpose of this discussion is to illustrate that research in bulk/dispensing systems has hardly reached its infancy and that the current emphasis on disposable packaging could be diminished if these systems were more practical and cleaner. A sophisticated system is not necessarily required; more likely is the need for one that has its ingenuity disguised in simplicity.

Distribution/Collection Systems

To maximize the efficiency of returning packages for reuse or recycling to their originating source, a series of distribution/collection systems could be developed and formalized where inefficiencies currently exist. Standardization, which will be discussed following this subsection, could contribute to the streamlining of these systems.

To maximize the recycling and reuse potential which exists technologically, collection systems must be broad-based, include all sectors and be organized efficiently. The resource and energy savings achieved through management of packaging according to the hierarchy of the 3Rs is maximized with efficient distribution/collection systems.

These systems should be material specific in some cases, sector specific in other cases and user specific in other cases (e.g. residential, industrial/commercial). Many systems already exist. Beer container return systems and infrastructure are in place across Canada and enjoy high consumer acceptance. Pallet reuse infrastructure is highly developed in some industry sectors. Corrugated cardboard and boxboard recovery programs are well established, and curbside residential recycling programs have maintained high levels of participation. In spite of these existing infrastructures, however, the development of enhanced reuse/recycling infrastructures is one of the prime obstacles to maximizing 3Rs opportunities today.

Standardization

Standardization of packaging materials can streamline the collection/ distribution process and increase the feasibility of reuse and recycling. Standardization controls differences in the size and shape of packaging, minimizing the need to sort materials to prepare them for recycling. Brand distinction would be accomplished through labelling.

An example of this is the current recycling efforts at some fast food restaurants. Technologically, all their products can be sold in the same kind of material, but several kinds of plastic and paper are used. The result is that the different kinds of plastic and paper act as contaminants in the recycling process, which is designed to handle only polystyrene. If a single plastic type had been chosen, not only would the problem be eliminated, but the plastic item that is now a contaminant would become a resource in the recycling process. This example is not a comment on the concept of recycling fast food disposables, only on the significance of standardization on 3R implementation.

In the case of reuse, standardization allows for efficient centres for washing (if necessary) and

handling from where shipments of specified sizes can be sent to the allocated companies for use. Sorting is limited to size rather than size and brand, streamlining the process.

Wood pallets, reusable glass containers, water jugs, plastics for certain applications (e.g. crates, fast food, rigid containers) are materials that are particularly well suited to standardization.

Product Concentration

Some products are low in concentration, while others can be easily concentrated (even though they are not particularly low) thereby reducing transportation and packaging requirements. For example, many laundry soaps contain 40% 'filler' which could be removed without affecting the performance of the product. Some products which have high water content, especially ones which are chemically formulated (i.e. water is added in the production process), could be increased in concentration. On the other hand, excessive product concentration has the potential to increase health risks associated with misuse of the product, and to encourage over-use of the product.

The potential for concentrations is limited to a few specific applications, most notably in cleaners. Recent initiatives such as the Proctor and Gamble Inc. Enviro-Pak for several domestic cleaners demonstrates the potential for product concentration initiatives.

Disposable to Durable

A movement, no matter what the material, from disposables to durables will result in reduced packaging. Fast food restaurants are an excellent example of an entire industry organized and completely oriented towards disposables. The reuse of a durable plate 100 times results in the replacement of 99 disposable plates with one durable plate. Many of the previous sections provided examples of opportunities for converting disposables into durables.

Substitution

The potential impact of 3R opportunities, as summarized in Section 10, assumes the status quo of packaging material usage. Significant change can be realized which is not taken into account in the summary by substituting one material for another, thereby providing increased opportunity for packaging reduction, reuse and recycling.

Substitution allows for the manipulation of the use of materials to allow for the desired mix of material management. For example, if reuse is a preferred management method, then materials which a high reuse potential could be favoured over ones which do not.

To indicate the potential significance of substitution on packaging quantities, the following example is provided. If 60% of milk were provided in pouches, there would be a 30,000 tonne reduction in packaging required.

It is not the intent of this document to recommend specific areas where substitution of one packaging type for another should take place. Such an approach may lead to perceptions of "good" packaging and "bad" packaging that are inappropriate at this time. Further, the issues that must be addressed in determining environmentally preferred packaging are discussed in the companion report to this document titled "Environmental Life Cycle Of Packaging". At the same time it is clear that major reductions in the tonnage of packaging discarded to landfill could be achieved through substituting lighter materials for heavier ones. It does not necessarily follow, however, that volume reductions would also occur to the same degree.



10.0 POTENTIAL IMPACT OF 3R TECHNOLOGICAL AND NON-TECHNOLOGICAL OPPORTUNITIES

Potential Impact of 3R Opportunities

Given the opportunities for packaging reduction, reuse and recycling described in this report, the potential impact of these opportunities on packaging materials management can be estimated. As indicated at the outset of this document, these estimates should not necessarily be considered 'targets' for 3R activity since the development of such targets must also take into consideration legislative, economic, social and other factors, which are discussed in other documents prepared in support of the national packaging policy (see the Preface to this document). Rather, the estimates in this section identify the capabilities that exist in Canada to manage packaging through 3R approaches; the extent to which these capabilities can be implemented is subject to the other factors noted. In addition, the estimates in this section are based on best available data, which are not necessarily comprehensive. Nonetheless, industry consultations related to these data have resulted in a high degree of consensus regarding the overall magnitude of 3R impact that can be technologically achieved in Canada.

In previous sections, opportunities for reduction, reuse and recycling have been described on a material - specific basis. These opportunities are quantified on an estimate basis in those sections and the potential impact of 3R opportunities on management of packaging materials is summarized in Table 10-1.

Table 10-1 indicates an overall technological reduction potential estimated at 9 percent by weight. Technologically, an estimated one-third of packaging by weight could be designed as reusable packaging in current applications; in 1988, an estimated 11 percent of packaging was reusable. Approximately three-quarters of packaging by weight could be recycled from a technological perspective; in 1988, an estimated 18 percent of discarded packaging was recycled.

Table 10-1

**Estimated
Potential Technological Impact
of 3R Opportunities
on
Management Of Packaging Materials - 1988¹**

Material	Reduction		Reuse		Recycling	
	Percent	Tonnes	Percent	Tonnes	Percent	Tonnes
Paper	14	(392,000)	20	(563,000)	80	(2,252,800)
Steel	5	(19,000)	8	(30,400)	100	(380,000)
Aluminum	5	(1,500)	0	(0)	80	(60,400)
Plastics	5	(41,000)	12	(98,760) ²	50	(411,500)
Glass	10	(73,500)	30	(220,000) ³	75	(551,250)
Wood	<1	(Minimal)	90	(714,000)	98	(778,120)
Overall Technological Potential	9	(527,000)	33	(1,847,160)	78	(4,434,070)
Existing Packaging Management			11	(577,000)	18	(961,000)

¹ 3R potential for composites has traditionally been low. Composites may be lighter than other materials, so their environmental benefits to date have been primarily in areas such as reduction of energy required for transportation and reduction in materials required for manufacture. New efforts are not underway to develop 3R management systems for composites, notably by Tetra-Pak with respect to aseptic packaging.

² Reuse could be increased if the design of packaging were altered (e.g. flexible to rigid packages) in many applications. Reuse of plastics is currently restricted in food and beverage applications by health regulations.

³ This figure approximates current reuse of beverage containers.

There is high consensus within industry that the reduction potential identified for each packaging material in Table 10-1 is technologically achievable. In the case of paper/paperboard packaging, achievement of the estimated reduction potential would require amendment of standards that are required for insurance purposes, but which the industry considers out-dated (see Section 2). In all cases, estimated reduction potential is based on the lightweighting and thinwalling of packaging and containers.

Reuse potential is more difficult to quantify. The data in Table 10-1 estimate reuse potential on the basis of the technological feasibility of reusing existing packaging materials in their current applications. In some cases, achievement of the estimated technological reuse potential identified in Table 10-1 would require product redesign; in the case of wood packaging, for example, all pallets could be reusable if manufactured from dense-grained tree species. The glass industry maintains that higher levels of reuse than indicated in Table 10-1 for that material are not possible, although others have suggested that the technological potential for glass reuse is at least double the estimate in Table 10-1 if it is assumed that all glass used by the food and beverage industry were redesigned for reusability and appropriate reuse infrastructures were put in place.

Generally, the development of reuse systems is not supported by either the packaging material sectors or the consumer products industry with respect to consumer packaging. The reasons for this are not technological in nature, but relate to economics. In the case of the packaging material sectors, reuse implies lower production of packaging and, hence, reduced sales of packaging units. The glass industry is particularly sensitive to this in light of the strong competition it currently faces from other packaging materials. In the case of the consumer products industry, reuse is not generally an attractive option because of the costs that would be incurred if retail outlets were expected to handle used reusable consumer packaging. This is already a particular concern for the grocery industry with respect to returnable soft-drink containers.

On the other hand, packaging reuse is attractive to many industrial/commercial users of packaging. The grocery industry has been a key force in the widespread adoption of reusable

pallets in the consumer products industry for the bulk delivery of consumer products at wholesale and retail outlets; the automotive industry continues to investigate the standardization of packaging used for the delivery of automotive components, which would create new opportunities for reusable packaging.

There is high consensus on the estimated technological potential for recycling. Industry already has well-defined technical standards relating to the amount and specifications of secondary material that can be used in the manufacture of new products. The estimated current recycling potential associated with plastics is low relative to other materials due to the strict technical requirements for recycling single-resin plastics and the emergent stage in Canada of mixed-resin plastics recycling technology; as new plastics recycling technologies now being demonstrated in Canada become proven, potential for plastics recycling will rise.

It should be noted that the data in Table 10-1 are not additive. The tonnage data provided in the Table identify the estimated tonnage impact that would have occurred in 1988 if the 3R opportunities identified had been fully realized. If the estimated reduction opportunities had been fully realized, however, a reduced weight of packaging would have been available to be impacted by reuse and recycling opportunities. In addition, the realization of reuse opportunities may severely constrain reduction opportunities associated with lightweighting and thinwalling, since thicker packaging may be required to withstand the rigours of reuse systems.

10.1 Potential Impact of Non-Technological 3R Opportunities

The quantitative impact of the non-technological 3R opportunities (e.g. bulking/dispensing systems, standardization, increasing product concentration, converting from disposables to durables and other forms of substitution) are difficult to quantify. However, depending on the extent to which they are implemented, they may increase reduction, reuse and recycling very significantly above the technological potential outlined in Table 10-1. Clearly, the realization of non-technological opportunities for the 3R management of packaging can have an important role to play in enhanced 3R management of packaging overall. However, the realization of non-technological opportunities for the 3R management of packaging requires that choices be

made about packaging systems themselves and in some cases, the products they contain. While it is important to recognize the important potential contribution of non-technological opportunities to the 3R management of packaging, the quantification of these opportunities is beyond the scope of this document.



11.0 RECOMMENDATIONS

Although the data contained in this document are in many cases estimates, there is widespread agreement in industry that the technological potential for the diversion of packaging from disposal through 3R approaches is great. Thus, while new and better technology is always desirable, we have the technological potential today to divert the major proportion of packaging from disposal. Technology is not currently the limiting factor in enhanced 3R management of packaging; the key issues related to the enhanced 3R management of packaging relate to the economical, legislative, social and other factors that must be considered in creating an environment conducive to maximizing the application of 3R approaches. New initiatives to divert packaging from disposal should not necessarily wait for new technology but must be sensitive to other factors that affect how, when and to what extent 3R technologies are applied.

Significant 3R activity is currently being undertaken to divert packaging from disposal. This activity is occurring with respect to both consumer and industrial/commercial packaging. Consequently, infrastructures exist on which to build greater efforts to divert packaging from disposal. Infrastructures vary across the county, however; nowhere are they sufficient to accommodate the level of 3R activity that will achieve the technological 3R potential for the management of packaging identified in this document. The development of expanded infrastructures should be a priority activity to enhance the 3R management of packaging.

Maximizing the impact of 3R approaches on the diversion of packaging from disposal will require an integrated approach that recognizes the contribution of each 'R'. In the development or choice of environmentally preferred packaging, trade-offs are likely to be necessary between each 'R', for example the choice to maximize source reduction may preclude reuse of a package, or may involve adoption of a non-recyclable package. Multi-stakeholder partnerships between industry, government and environmental/consumer groups should be established to identify solutions to specific obstacles industry sectors and packaging suppliers face in developing and implementing integrated 3R approaches to the management of packaging. The environmental basis for choosing preferred packaging and packaging

identify the key environmental impact and merits of packaging and packaging management systems.

Many non-technological opportunities also exist to divert packaging from disposal. These opportunities relate to how the various functions of packaging are prioritized, the options considered when designing products and packaging systems, and the packaging demanded by consumers. Initiatives to divert packaging from disposal must take these opportunities into consideration in order to achieve maximum impact.

APPENDIX A

Technical Specifications For Cullet In Quebec



OBJET: QUALITÉ DU CALCIN

Le calcin est utilisé comme matière première par les verriers; il sert à produire de nouveaux contenants et non des sous-produits de moindre qualité.

Les verriers exigent donc un niveau de qualité semblable aux matières premières qui servent à produire le verre, soit le sable, la chaux et la sonde.

En résumé, les verriers exigent que le calcin soit de 99.9% à 100% pur selon les différents contaminants. (Voir pièce ci-jointe pour détails).

Les contaminants les plus sérieux sont les suivants:

a) Matières réfractaires:

Ex: tasses, assiettes, porcelaine, gré. La tolérance est essentiellement 0%. Une tasse dans un chargement de 30 tonnes gaspille le chargement.

b) Métaux:

Capsules, emballages, étiquettes, métaux quelconques. Les verriers exigent un maximum de moins qu'une once de métal par tonne de calcin, ie moins "qu'une cuillère à sucre" par tonne de calcin.

c) Papier, plastique, bois, guénilles, autres matières organiques
Moins que 4 onces/tonne.

d) Humidité, glace, neige
Moins que 0.5%.

e) Composition chimique
Aucun, soit 0%. Seulement du verre de contenant. Pas d'ampoules de verre, verre plat, miroir, etc.

f) Séparation par couleur
Pas de couleur mélangée. Normes strictes pour les trois couleurs, soit clair, vert et ambre.

g) Grosseur de calcin
Doit être broyé selon les normes.

Les verriers doivent exiger ces normes très sévères à cause de la nature de la production du verre et du produit fini. Les contaminants tels les réfractaires et les métaux ne fondent pas dans le procédé de production et se retrouvent dans les parois des contenants. Les métaux endommagent aussi les fours. Ces contaminants diminuent considérablement ou complètement la résistance du contact à l'impact et à la pression interne du contenant. Une bouteille de liqueur douce qui doit résister à plus de 225 lbs/po ca. de pression interne éclatera à la moindre pression ou choc soit lors de son remplissage chez l'embouteillage ou pire dans les mains d'un consommateur.

Les verriers doivent donc observer des normes de qualité très élevées, en particulier la résistance au bris.

Le nombre maximum de bris accepté par les manufacturiers d'aliments, bières, liqueurs douces et autres est maintenant de l'ordre de 10 par 100,000 contenants remplis. Ces manufacturiers demandent maintenant aux verriers de viser un niveau de qualité "zéro défaut".

Tel que mentionné ci-dessus, ces normes élevées sont demandées pour causes économiques et sécurité dans leurs manufactures et afin de protéger les consommateurs.

La bouteille qui éclate sur la ligne de production de l'embouteilleur ou le pot de moutarde qui brise sur la ligne de production causent des arrêts de production de 10 à 20 minutes afin de décontaminer la ligne des parcelles de verre ou de produit répandu sur la ligne et la plancher.

Ces arrêts diminuent donc considérablement la productivité des manufacturiers. Les verres autres que ceux de contenant affaiblissent le verre lui-même.

Enfin, le verre doit être séparé par couleur pour maintenir des couleurs uniformes. Le verre clair doit demeurer clair pour maintenir une qualité de teinte uniforme. Le verre ambre utilisé par les fabricants de médicaments et de bières doit se conformer à une teinte spécifiée afin de résister à la lumière. Le verre vert doit aussi se conformer à une teinte uniforme pour des raisons d'apparence et d'uniformité et aussi résister à la lumière pour des produits tels les vins et la bière.

RÉSUMÉ DES SPÉCIFICATIONS

QUALITÉ DUCALCIN

(Suite)

<u>TYPE DE CONTAMINANT</u>	<u>NIVEAU TOLÉRABLE DANS LE CALCIN TRAITÉ</u>	<u>RAISONS</u>	<u>EXIGENCES</u>
Verre ambre	98% ou plus de verre de contenant ambre. Maximum de 1% de verre de contenant clair. Maximum de 1% de verre plat clair. Maximum de 1% de verre vert pâle ou de verre brun/vert. Maximum de 2% de verre vert foncé.	Les tolérances de la couleur et de la transparence du verre ambre sont sévères.	
Verre vert	90% ou plus de verre vert foncé. Maximum de 10% de verre de contenant clair. Maximum de 10% de verre de contenant ambre. Maximum de 10% de verre vert pâle ou de verre brun/vert. Maximum de 3% de vert bleu.	Couleur doit être stable.	
<u>Gros- seur du calcin</u>	Maximum 6cm ³ Maximum 4cm ³ 98% de 4cm ³ à + 40 mesh Maximum 5% - 20 mesh	Les morceaux ne doivent pas être trop gros afin de pou- voir les fondre dans les fours. Lorsque broyé trop petit, le calcin s'envole et pollue l'atmosphère.	

RÉSUMÉ DES SPÉCIFICATIONS

QUALITÉ DUCALCIN

(Suite)

<u>TYPE DE CONTAMINANT</u>	<u>NIVEAU TOLÉRABLE DANS LE CALCIN TRAITÉ</u>	<u>RAISONS</u>	<u>EXIGENCES</u>
<u>Composition chimique</u>	Seulement du verre de contenant. Pas de borosilicates (T.V., fibre de verre, verre de laboratoire, ampoules de verre, etc) Pas de matériaux non verre. Pas de verre argenté, miroir, teint ou coloré. Pas de verre laminé ou avec fil métallique.	Cause des changements dans les propriétés du formage du verre, stabilité et la couleur.	0% de contamination
<u>Séparation par couleur</u>			
Verre de couleur mélangé	Pas accepté.	Ne pourrait être utilisé que dans le verre vert. Cause des problèmes de stabilité, de composition, de couleur.	
Verre clair	99% ou plus de verre de contenant clair. Maximum de 0.5% de verre de contenant ambre. Maximum de 0.25% verre vert pâle (0.04% Cr₂O₃, maximum). Maximum de 1% de verre décoré avec émail vert ou bleu. Pas de verre bleu ou vert. Maximum de 5% verre décoré.	Le verre de couleur teinte le verre clair.	

RÉSUMÉ DES SPÉCIFICATIONS

QUALITÉ DUCALCIN

<u>TYPE DE CONTAMINANT</u>	<u>NIVEAU TOLÉRABLE DANS LE CALCIN TRAITÉ</u>	<u>RAISONS</u>	<u>EXIGENCES</u>
<u>Matières réfractaires</u> (Ex: tasse, assiettes, porcelaine, gré)	Pas de morceau plus grand que 1 mm ³ Moins de 10 morceaux par tonne de calcin	Cause des inclusions dans le contenant de verre.	0% de contamination.
<u>Métaux</u> (Capsules, enrobages étiquettes, métaux quelconques)	Pas de morceau présent plus que de 10 grammes Pas plus de 20 grammes par tonne de calcin (ie moins qu'une "demi-cuillère à sucre" par tonne de calcin).	Cause des inclusions dans le contenant de verre. Cause des dommages dans les réfractaires des fours.	0.002% de contamination. (ie 99.99% de pureté)
<u>Papier, plastiques, bois, guénilles, autres matières organiques</u>	Pas de morceau plus grand que 10 cm ³ . Moins que 100 grammes par tonne de calcin. Ne doit pas causer de blocages dans le système de manutention du calcin.	Bloque le système de manutention de calcin Modifie le niveau de carbone dans la fournée. Cause des pierres de fournée non fondues dans les contenants de verre.	0.05% de contamination (ie 99.95% de pureté.)
<u>Humidité, neige glace</u>	0.5% humidité libre totale. Pas de drainage visible ou quantités excessives de neige ou de glace.	Adhère au système de manutention. Humidité excessive de la fournée. Blocages dans l'entreposage et les pesées.	99.5% sec.